INDIAN ISLAND MOORINGS

PROJECT COMPLETION REPORT

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FPO-1-79(9)

OCTOBER 1979

OCEAN FACILITIES ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D. C. 20374

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Station (NUWES), for securing YC and YFN ammunition barges. Because of unusual site characteristics and tight positioning constraints it was imperative that the moorings be implanted in precise locations and that the mooring circles swept by the anchored barges be of minimal dimensions.

In June 1978, OICC trident requested the Ocean Facilities Engineering and Construction Project Office, Chesapeake Division Naval Facilities Engineering Command (CHESNAVFACENGCOM, FPO-1) to perform a design review and determin installation options for these three moorings. After studying the problem and evaluating the available assets, a construction team was assembled under the management of CHESNAVFACENGCOM that comprised a dive team from the Civil Engineering Laboratory, construction vessels and operating personnel from the State of Washington Army National Guard, and mooring rigging personnel from the Public Works Center, San Diego.

A plan of action, employing this construction team, with mooring system components to be provided by OICC TRIDENT, was approved on 30 November 1978 for accomplishing the installation during the January-February 1979 time frame.

Enginereing design studies were completeed, environmental data obatained, and, following a pre-installation conference with members of the construction team on 14-15 December 1978, a construction operations plan was issued on 15 January 1979. The constructon team assembled on 22 January 1979 and proceeded immediately with setting up navigation marks and with marker buoy installation. A final assessment of bottom conditions in the mooring area was completed by 25 January and gear for the first mooring was loaded aboard the construction vessels by 27 January. Iplantment of the three moors was accomplished in the folowing sequence: Moor #6 - 298 January; Moor #2 - 31 January; Moor #1 - 3 February.

Pull tests on all three moorings were complete on 3 February and the construction activities were terminated on 4 February 1979. Additionally, an old mooring in the area was removed at the request of the Western Division, Naval Facilities Engineering Command. The total Project was completed within the allotted time and funding.

TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

The Officer in Charge of Construction, Naval Facilities Engineering Command, TRIDENT (OICC, TRIDENT) was tasked to provide three fleet moorings on the west side of Indian Island, Puget Sound, Washington. These moorings were part of a total of six moorings to be installed for the Naval Undersea Weapons Engineering Station (NUWES), for securing YC and YFN ammunition barges. Because of unusual site characteristics and tight positioning constraints it was imperative that the moorings be implanted in precise locations and that the mooring circles swept by the anchored barges be of minimal dimensions.

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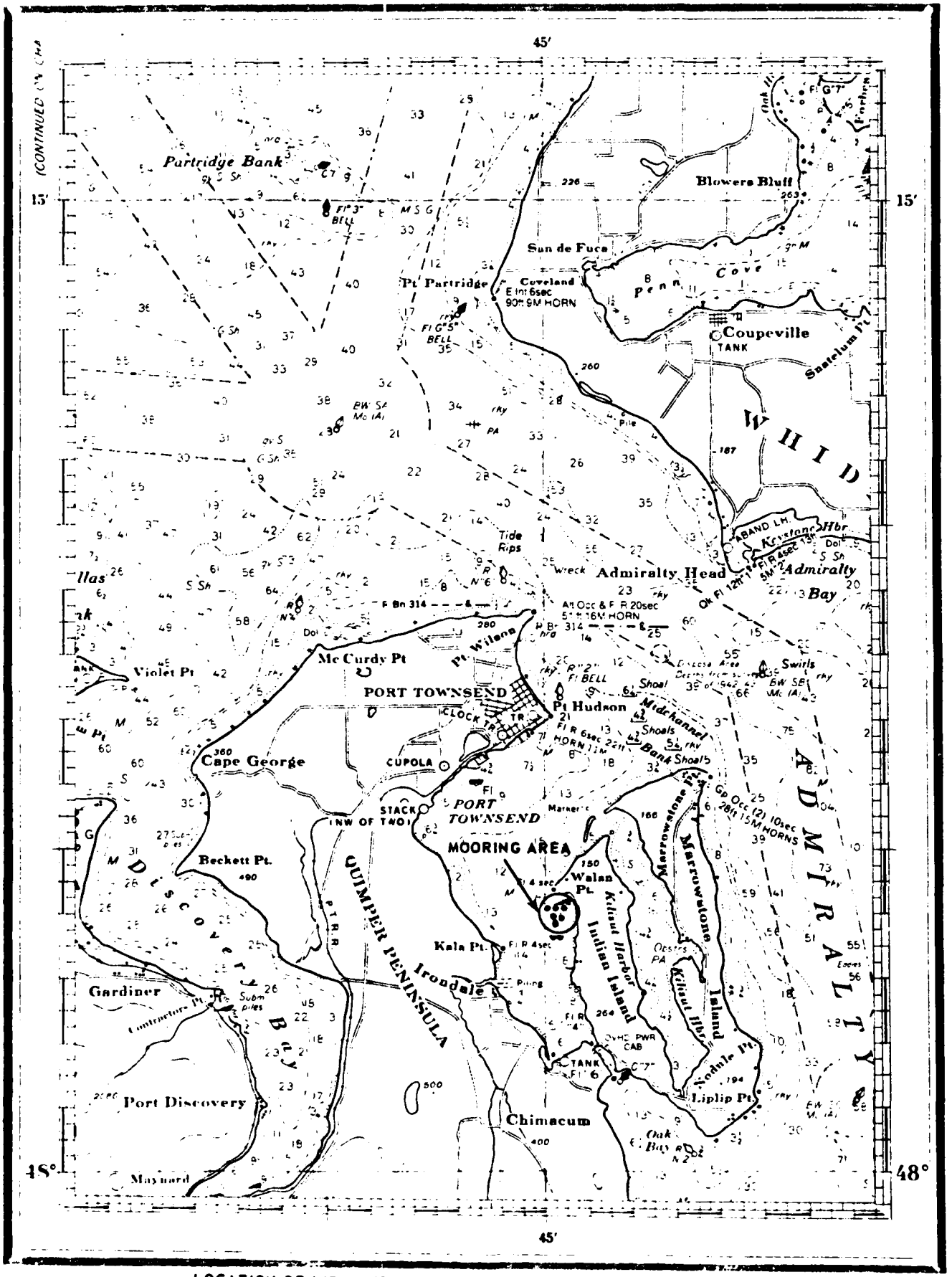
PROJECT DESCRIPTION

BACKGROUND

The Officer in Charge of Construction, Naval Facilities Engineering Command, TRIDENT (OICC TRIDENT) developed a requirement for the installation of six fleet moorings off Indian Island in Puget Sound, Figure 1; these moorings are a part of a new facility to secure YC and YFN ammunition barges. Due to unusual site characteristics and strict performance requirements, the project required precision placement of these deep water moorings, Figure 2. OICC TRIDENT requested the Ocean Facilities Engineering and Construction Project Office, Chesapeake Division, Naval Facilities Engineering Command (CHESNAVFACENGCOM) to perform a design review of three of these fleet moorings in June 1978.

After a series of discussions between OICC TRIDENT and CHESNAVFACENGCOM the latter command forwarded a plan of action in July 1978 delineating installation options and cost estimates for the proposed construction operation. Initially it was anticipated that U. S. Coast Guard platforms and personnel from Underwater Construction Team TWO (UCT-TWO) would be utilized in the installation operation but, after more detailed review of the installation and performance requirements it was concluded that the intended USCG vessels did not have the necessary lift capability to install Class C mooring components; furthermore it was determined that UCT-TWO personnel would not be available during the January-February 1979 construction period. Consequently a different composition of vessels and personnel was proposed to form a government team to carry out the project.

The new team comprised a dive team from the Civil Engineering Laboratory, and a crane barge, tugs, and operating personnel from the State of Washington Army National Guard and mooring riggers from the Navy Public Works Center, San Diego. CHESNAVFACENGCOM would continue to assume responsibility for design,



LOCATION OF INDIAN ISLAND OFF ADMIRALTY INLET, PUGET SOUND

FIGURE 1

construction, and project management. A revised plan of action and cost estimated was formulated on the basis of utilizing this team.

WORK SCOPE

The revised plan, forwarded to OICC TRIDENT by CHESNAVFACENGCOM on 24 November 1978 outlined the following scope of work for the Indian Island moorings:

o *Sea Floor Site Survey.* Define requirements for a sea floor site survey consisting of acoustic subbottom profiling and anchor pull tests. Prepare a Scope of Work and Government Cost Estimate for OICC TRIDENT to utilize engineering services firms already under contract. Accompany survey crew to monitor conduct of survey and obtain on-site interpretation of results for immediate use in design analysis.

o *Design Analysis.* Develop design criteria based on facility performance requirements, site characteristics and construction capability. Evaluate performance of free-swinging (Class C) riser-type moorings using components provided by OICC TRIDENT. Determine lengths of chain and height of ground ring above bottom needed for a reasonable watch circle. Define facility acceptance criteria and proof testing procedures.

o *Installation Planning.* Determine the requirements for and availability of platforms, equipment, and personnel. Research meteorological data (weather window) for the construction period. Task/coordinate assembly of the government construction team. Specify type/size of rigging hardware and support equipment and arrange for shipment to site. Develop an installation plan/procedure based on the mooring design, site characteristics, construction capability and requirements for a facility acceptance/proof test.

o *Installation (On-Site).* Direct/coordinate construction operations consisting of mobilization and transit, pre-rigging, installation of the moorings, proof testing, and adjusting the position and/or watch circle of each mooring to meet performance requirements.

o *Completion Report.* Provide to OICC TRIDENT at end of project a letter report consisting of the results of the acceptance/proof tests and as-built drawings.

Based upon OICC TRIDENT approval of this proposed scope of work, a Project Execution Plan was developed to carry out the installation of the first three Indian Island moorings.

TASKING, RESPONSIBILITIES, AND INTERFACES

PROJECT TASKING

The concurrence of OICC TRIDENT with the CHESNAVFACENCOM initial plan of action was expressed in Speedletter 09A232/DAC/dl 7302 of 1 September 1978 and funds were forwarded to initiate further work. The revised plan of action was approved in OICC TRIDENT message 291810Z of 30 November 1978 and additional funds were forwarded with a request to proceed immediately.

Based upon these requests the responsibility for designing the moorings, for managing the operation, and for coordinating the efforts of the government team was placed upon CHESNAVFACENGCOM. This organization, in turn was charged with tasking and assigning responsibilities to: the Watercraft Support Maintenance Center (WSMC) of the Washington Army National Guard, Tacoma, Washington; Navy Public Works Center (PWC), San Diego, California; Civil Engineering Laboratory (CEL), Port Hueneme, California.

WSMC was requested to participate in the project and to provide a crane barge, tugs, and crews by CHESNAVFACENGCOM message 072152Z on 7 November 1978. Acceptance was in the form of a telephone conversation between LTC J. Johnston of WSMC and A. Kurtz of CHESNAVFACENGCOM on 7 December 1978.

PWC, San Diego was asked to furnish assistance in rigging for the installation by CHESNAVFACENGCOM message 111928Z on 11 December 1978 and PWC replied affirmatively in message 031643Z on 3 January 1979.

Diving locker services were requested from CEL by CHESNAVFACENGCOM message 131946Z of 13 October 1978 and CEL agreed to furnish these services by message 190137Z on 19 October 1978.

AS-BUILT CONFIGURATION

The installation of Moors #1, #2, and #6 at Indian Island was completed on 3 February 1979, as described in the Log of Contruction Operations, Appendix A. The three moorings were installed within the scheduled time framework and all personnel involved returned to their respective stations. These moorings were in accordance with the basic design contained in the Project Execution Plan with minor exceptions that are delineated below.

LOCATION OF MOOR CENTERPOINTS

As discussed in the navigation and marker buoy installation log in Appendix A and also in Appendix B, there was a problem in locating one of the geodetic markers at Kala Point which resulted in erroneous determination of the three moor centerpoints. The Washington State grid coordinates for the as-built locations are compared with the design locations in the following table.

Mooring #	Design	As-Built	Difference of As-Built From Design
1	N 394,545 E 1,531,655	N 394,519 E 1,531,558	S 26 Ft W 97 Ft Error 100.4 Ft
2	N 394,570 E 1,532,455	N 394,572 E 1,532,350	N 2 Ft W 105 Ft Error 105.0 Ft
6	N 393,052 E 1,532,088	N 393,026 E 1,531,963	S 26 Ft W 125 Ft Error 127.7 Ft

The dislocation of the three moors from the design targets averages 111 feet to the west, away from the Indian Island shore. When the error was initially detected the relocation of all three moors to the design centerpoints was considered. However, as illustrated in Appendix C, page C-5, the altered watch circles of the buoys, with ammunition barges moored thereto, still fell outside the specified minimum radii from the small craft facility, the saw shed, and the mine shops. The watch circle for Moor #1 was still within the allowable distance from the Indian Island shoreline and there remained adequate room for the later installation of Moor #3 offshore of the limiting mooring depth.

In view of the facts that the location errors were consistent for the three moors and that the prescribed distance from shore facilities were maintained, it was agreed that the cost required to relocate the three moors to the design points was not warranted. The remaining three moors could later be placed to fit within this altered location plan.

The installed locations of Moors #1, 2, and 6 are shown in Figure 3, together with depth contours derived from an earlier survey by Shannon & Wilson, Inc. The mean lower low water depths for the three moors are: #1 - 88 feet; #2 - 81 feet; #6 - 85 feet.

MOORING WATCH CIRCLES

The design mooring circle radius for each moor was 235 feet, which comprised a buoy location tolerance of ± 20 feet, a watch circle radius of the buoy under 12 kip load of 50 feet, a bridle length of 75 feet, and a barge length of 110 feet. The design circles shown on Figure 3 show this radius without the ± 20 foot tolerance, i.e. a 215 foot radius. Based upon the pull test results it was found that Moors #2 and #6 had corresponding radii of 218 feet and 217 feet. The circle for Moor #1 was actually an ellipse with a major axis of 250 feet and a minor axis of 220 feet. Since all watch circles lay outside of the stipulated distances from shore installations and minimum separation arcs it was considered that the moors were installed in conformance with the basic requirements.

MOORING SYSTEM COMPONENTS

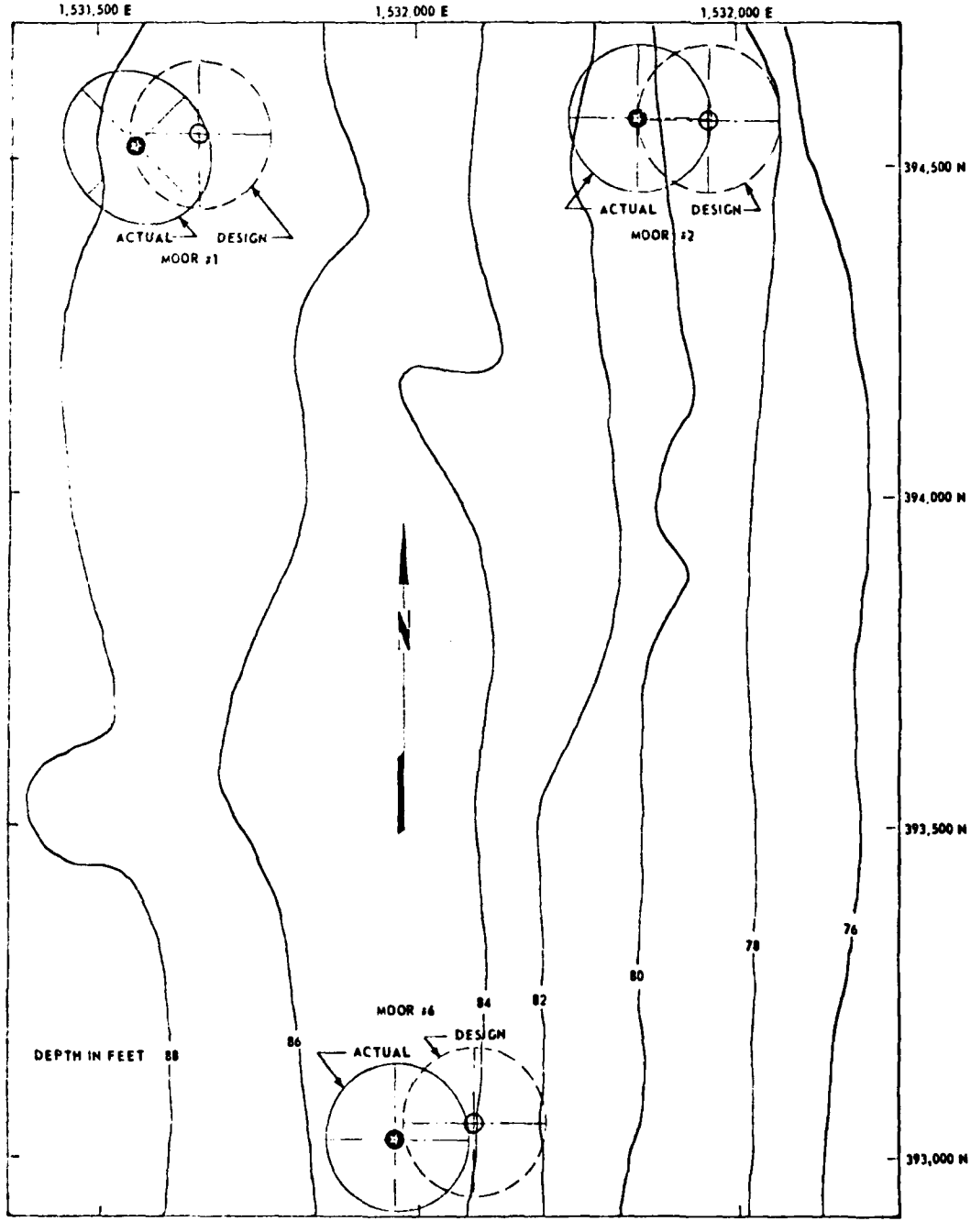
The components utilized in the three Indian Island moors comprised basically the standard elements of free-swinging (Class C) riser-type moorings furnished by OICC TRIDENT. In addition, some connectors were drawn from the materials trucked to the site by PWC personnel and other components were obtained on site at Indian Island.

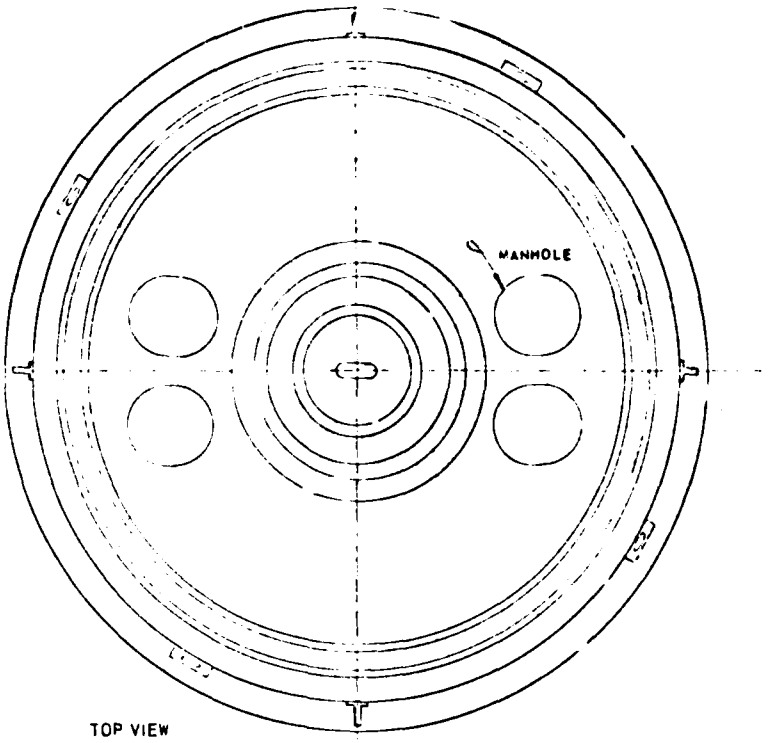
Although the original design had contemplated the use of 2 1/4-inch chain risers from the ground rings to the buoys, it was agreed to utilize available 2 1/2-inch chain for this purpose. The buoys employed were of the standard peg top type with principal dimensions as illustrated in Figure 4.

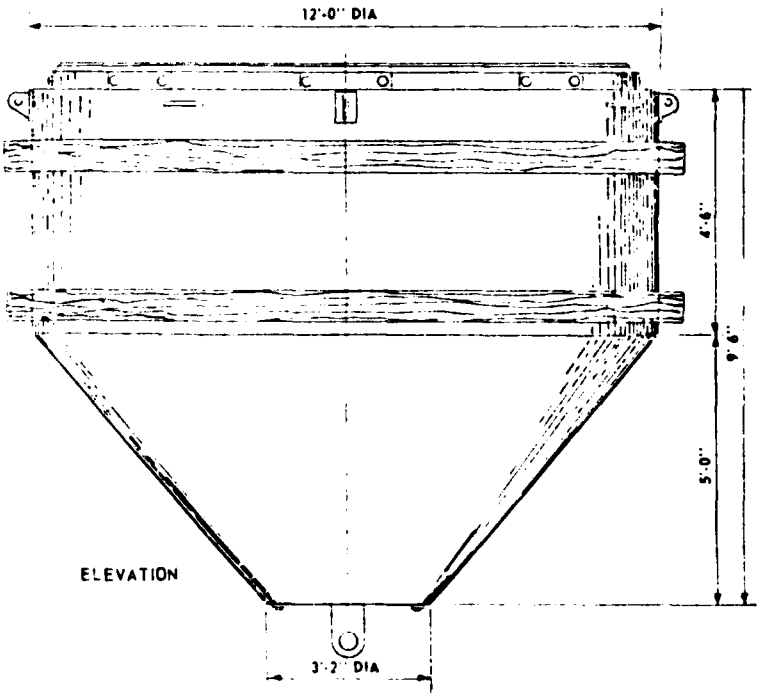
Since the water depths for the three moors varied by a few feet, Figure 5, and also since the relation of ground ring height off bottom to riser length

INSTALLED LOCATIONS OF INDIAN ISLAND MOORINGS

FIGURE 3

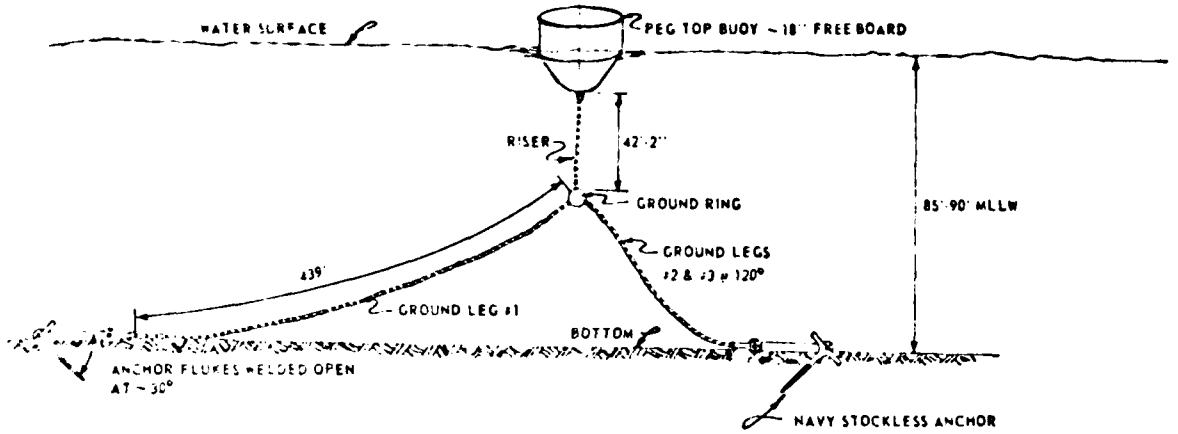






STANDARD PEG TOP BUOY

FIGURE 4



FINAL INSTALLATION WITH SHORTENED
RISER AND GROUND RING RAISED

FIGURE 5

would vary somewhat depending upon the tide height at the time of implantment and riser shortening, it had been planned to vary the riser length accordingly. However, a decision was made during construction that this would be an unnecessary refinement. Therefore all three riser lengths, from the bottom of the buoy to the inside bottom of the ground ring, were 42' - 2". As can be seen in Figure 6, the hardware in all three risers was identical.

The various ground leg lengths differed slightly because of the variation in hardware used. Also as shown in Figure 6, the average ground leg length was 439.3 feet with maximum deviations of + 11.50 feet and - 12.40 feet. Additionally the wire size of the anchor jewelry varied due to the use of refurbished components. In such cases the smallest measured diameter is tabulated. The anchors used for Mooring #1 were 20000# Navy Stockless whereas the other six anchors were 18000# Navy Stockless.

Figures 3, 4, 5, and 6 constitute the final As-Built drawings for the Indian Island Mooring Project. This report and the above drawings supplement the preliminary report, Appendix C, which was submitted to OICC TRIDENT by CHESNAVFACENGCOM on 28 February 1979.

It should be noted that if any vessels other than the intended YC and YFN ammunition barges are secured to these moorings there is a risk of pulling slack into the ground legs and consequently expanding the watch circles beyond

the allowable minimum radius. Warnings should be posted on each mooring buoy to the effect that they are not to be used by commercial vessels or other Navy vessels that might cause such a dislocation.

APPENDIX A

LOG OF CONSTRUCTION OPERATIONS

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During the course of the Indian Island mooring construction operations there were a number of activities that were proceeding in parallel or were overlapping in time. In order to delineate these events in as lucid a manner as possible, the various activities have been classified under one of the following headings:

- o Navigation and Marker Buoy Installation
- o Bottom Condition Assessment
- o Supplementary Work on Existing Mooring
- o Mooring System Preparations on Crane Barge
- o Mooring Installation and Testing

Some of these activities involved personnel from all four primary organizations involved whereas others were the responsiblity of one organization alone. In this narrative, only the organizational names will be used when referring to specific personnel; the actual participants being identified in Appendix D of this report. For convenience these organizational identifications will be abbreviated as follows:

FPO-1 = Chesapeake Division, Naval Facilities Engineering Command, Ocean Engineering and Construction Project Office, Washington Navy Yard

PWC = Public Works Center, San Diego, California

CEL = Civil Engineering Laboratory, Dive Locker, Port Hueneme, California

WSMC = Watercraft Support Maintenance Center, Washington Army National Guard, Tacoma, Washington

OICC = Officer in Charge of Construction, Naval Facilities Engineering Command, TRIDENT

ROICC = Resident Officer in Charge of Construction, Indian Island

NUWES = Naval Underwater Weapons Station, Keyport, Washington

Additionally, when logistics support, transportation, delivery or condition of material relates to one of the construction activity classifications it will be discussed in conjunction with that construction activity but complete lists of materials and equipment used will be included in the appendices.

NAVIGATION AND MARKER BUOY INSTALLATION

22 Jan.-1130: FPO-1 personnel arrived at Seattle/Tacoma airport together with equipment from CHESNAVFACENGCOM stock and transmitted to Indian Island.

23 Jan.-0800: Set up navigation center aboard LT-2076 including preparing bridge for Mini-Ranger and charts, taping range rings to charts, setting up console on chart table, and tying receiver/transmitter unit to the mast. The Mini-Ranger power cord was wired into the ships 24 volt power system.

23 Jan.-1000: Found that the batteries for the Mini-Ranger were dead and that the cable for the printer to the Mini-Ranger had the wrong plug attached. (The cable was shipped from vendor to CEL and was not received until after Mini-Ranger was on the truck for shipment.) All data were thus recorded manually.

23 Jan.-1030: With the receiver/transmitter unit and cables secured aboard the LT-2076, FPO-1 personnel went ashore at Crane Point and at Kala Point to set up transponders. The Crane Point transponder was designated Code C and Kala Point transponder was designated Code 8. Signals from both were received aboard the LT-2076. Locations are shown in Figures A-1 and A-2.

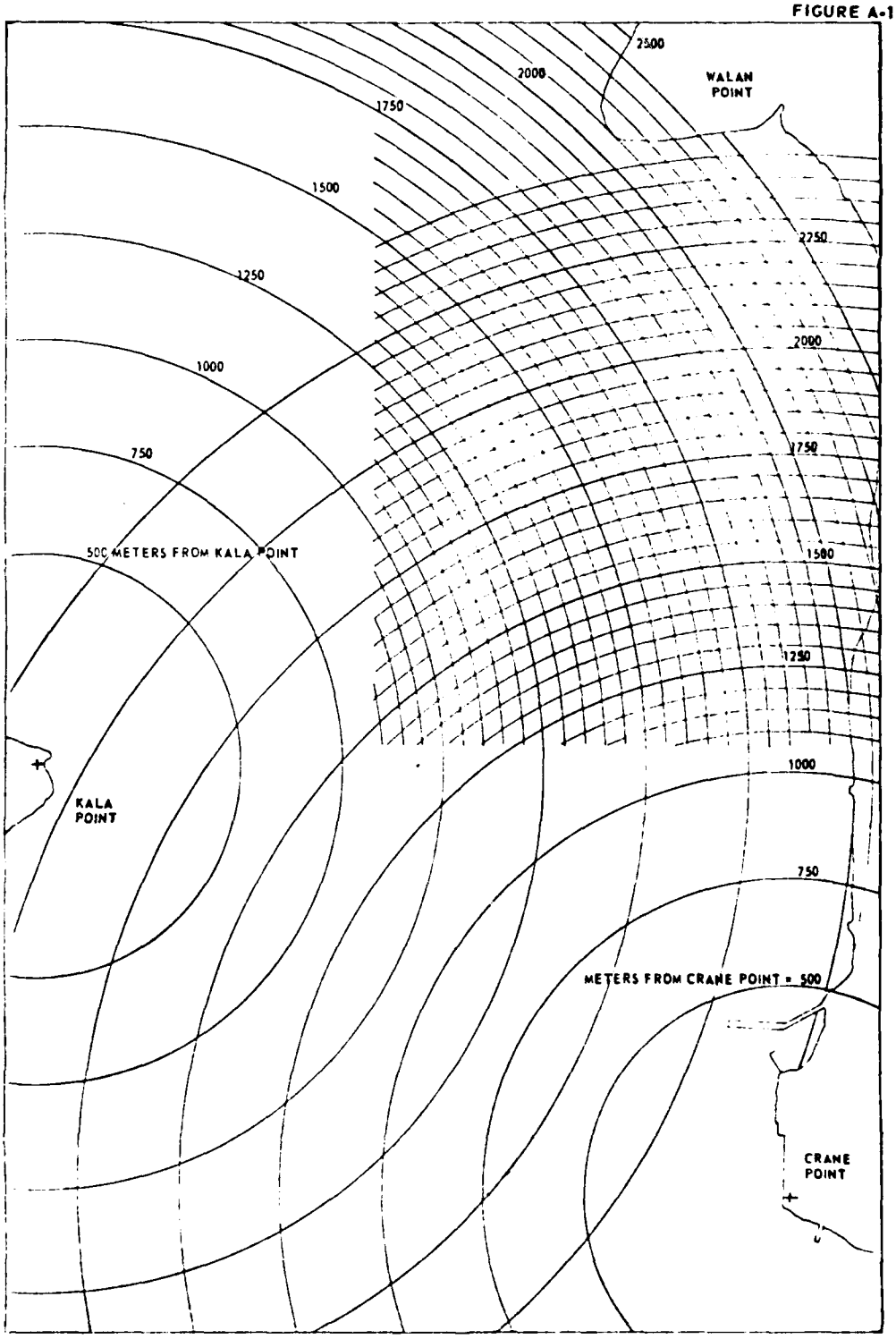
23 Jan.-1315: A second navigational station was set up aboard the ST-2154 and the Mini-Ranger console was placed on board and wired into the ships 24 volt batteries. A second receiver/transmitter was secured to the mast and checked out. It turned out that the spare Mini-Ranger system was inoperative and therefore it would be necessary to shift the console units from the LT-2076 to the ST-2154 whenever it was necessary to relocate the navigation system. However, the mast-mounted receiver transponders on the two ships were satisfactory.

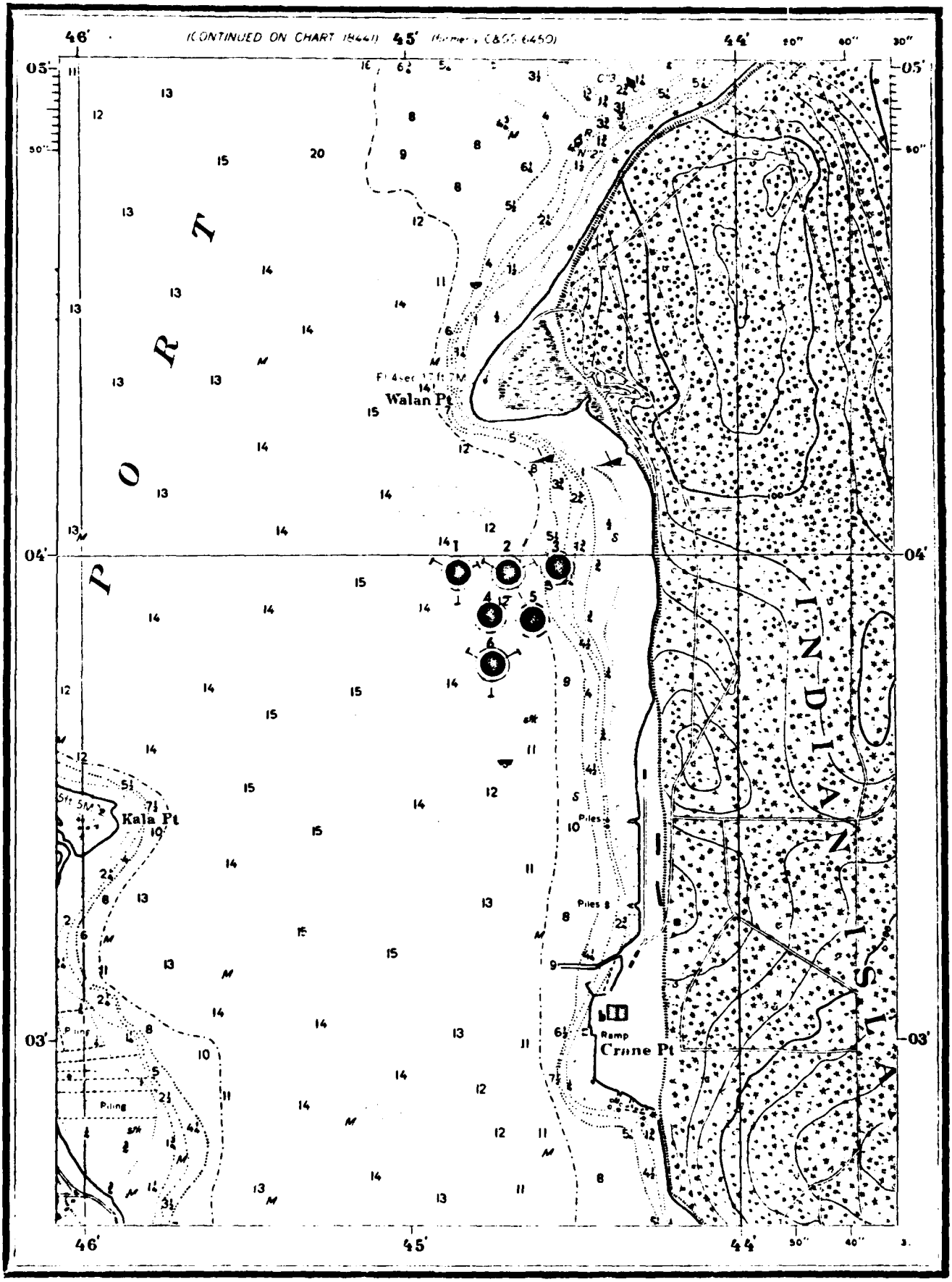
23 Jan.-1700: Departed LT-2076 to pick up shore transponder stations for recharging internal batteries.

24 Jan.-0630: Turned on Kala Point transponder station. This involved replacing batteries which were recharged all night during the operation.

MINI-RANGER NAVIGATIONAL CHART OF INDIAN ISLAND MOORING AREA

FIGURE A-1





PLACEMENT OF MOORINGS OFF INDIAN ISLAND

FIGURE A-2

24 Jan.-0820: Loaded marker buoys aboard the ST-2154; these consist of 20 foot lengths of PVC pipe which join together with twist lock joints. A bottom fitting was provided to permit the marker buoy to be tied to the anchor. It was planned to have the buoy of sufficient length to extend almost to the bottom and this length was floated off the stern. Once connection was made to the anchor, and lowering started, the joint broke at the first connection. Based upon successive attempts to use shorter lengths of pipes it was finally decided to use only one length of pipe with end connection to make up the marker buoy. Typical marker buoys are shown in Figure A-3.

At the same time, Mini-Ranger problems developed. There was interference between Crane Point and the LT-2076, the ST-2154, and the Crane Barge with the result that contact with the Crane Point transponder stations was lost.

24 Jan.-1030: At this point the ST-2154 was underway attempting to locate the old 1975 boring site B-10 but the blocking out of the Crane Point transponder prevented the location of the boring site.

24 Jan.-1215: One length of PVC pipe was added to extend the height of the receiver/transmitter on the mast of the ST-2154. With this it was hoped that an additional transponder installed at Walan Point could be contacted but this attempt did not succeed.

24 Jan.-1250: The Mini-Ranger console was returned to the LT-2076 for use in vibracoring operations and the tug got underway for these operations.

24 Jan.-1500: The crane barge was estimated to be in the general area of the 1975 B-10 site and a core was obtained. The barge then moved to the location of the existing mooring for additional coring work.

24 Jan.-1725: Left pier at Indian Island and went out to Kala Point and Crane Point to pick up transponders.

25 Jan.-0630: Returned to Kala Point and turned on transponder, Figure A-4.

25 Jan.-0745: Returned to Crane Point and turned on transponder, Figure A-5.

25 Jan.-0810: Transferred Mini-Ranger console to the ST-2154 and secured unit on board. Departed for site B-10 but still received no return signal from Crane Point and therefore returned to pier at Indian Island.

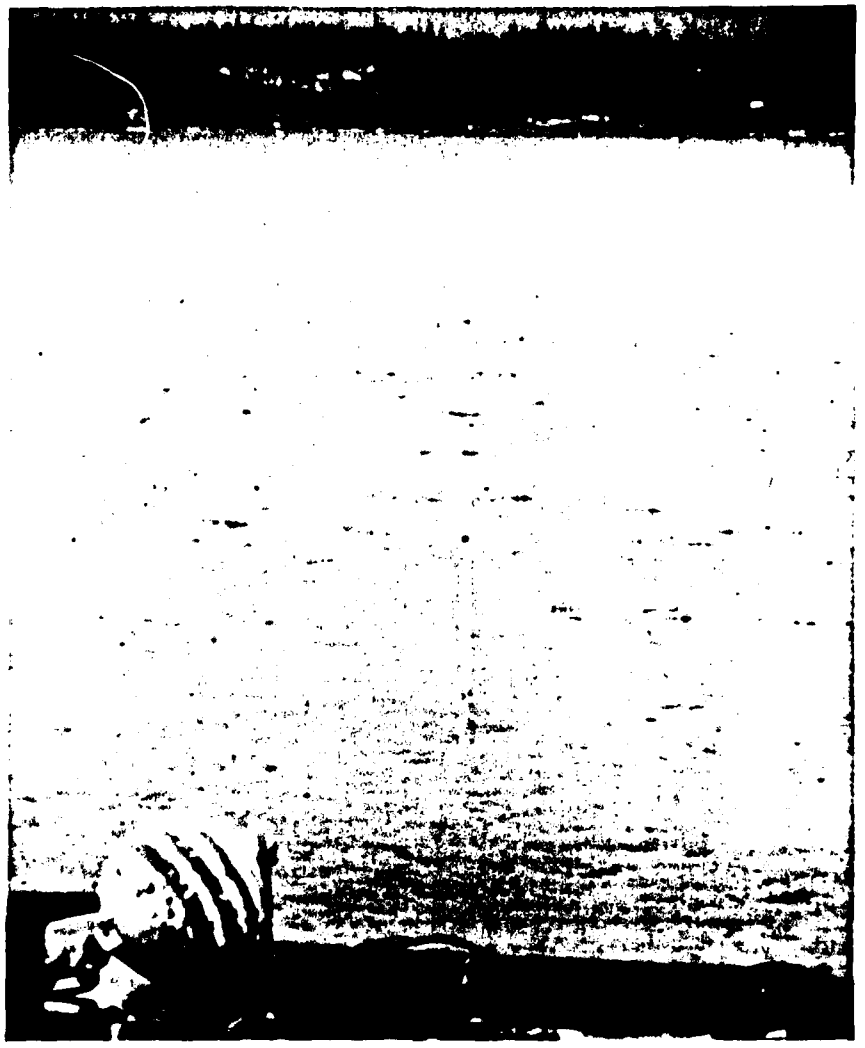


FIGURE A-3: TYPICAL MARKER BUOY INSTALLATION

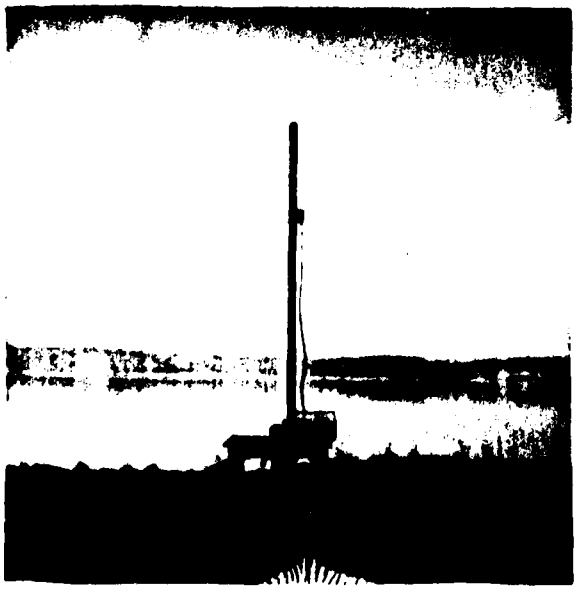


FIGURE A-4: KALA POINT TRANSPONDER

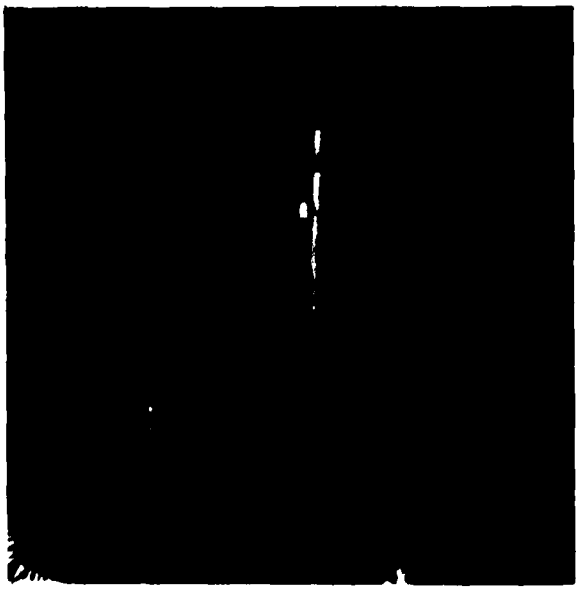


FIGURE A-5: CRANE POINT TRANSPONDER

25 Jan.-1015: Returned Mini-Ranger to LT-2076 and got underway to core site #3. Finished taking cores at this site at 1109 and obtained the following readings from the two transponders: Kala Point 1025 meters, Crane Point 1352 meters.

25 Jan.-1350: Secured the Mini-Ranger after having been unable to obtain fixes at core sites #4 or #5.

25 Jan.-1445: Transferred Mini-Ranger console back to ST-2154. However, contact with both shore stations was lost after leaving the pier. Kala Point could be picked up near the pier but was lost when in construction area.

25 Jan.-1535: It was determined that the Crane Point transponder worked when on external power but that the batteries in the transponder were dead. This was presumed to be either a battery charger problem or no power available in the outlet used for the charging system.

25 Jan.-1750: Power turned off at Kala Point.

26 Jan.-0600: Set up transponder stations at Crane Point and at Kala Point in preparation for setting out marker buoys for Moor #6.

26 Jan.-0800: Reworked previous day's data to obtain latitude and longitude of positions at which cores were taken.

Core	Latitude	Longitude
PSII #1	48° 03" 44" N	122° 44' 49.8" W
PSII #2	48° 03' 32.5" N	122° 44' 38.6" W
PSII #3	48° 03' 30.4" N	122° 45' 06.6" W
PSII #4	48° 03' 44.3" N	122° 45' 03" W

After this determination was made, departed for Crane Point to raise the height of the transponder.

26 Jan.-0840: After raising Crane Point transponder, FPO-1 called in for a navigation check and, as a result increased the height a total of 24 feet.

26 Jan.-0915: Transferred the Mini-Ranger console to the ST-2154 and found it necessary to change the receiver/transmitter unit on the mast since both stations tended to come in and go out with the existing unit. Position determination was satisfactory at the pier but blacked out in the mooring implant area.

26 Jan.-1025: With the replaced receiver/transmitter on the mast of the ST-2154 there still appeared to be blockage from Crane Point although the rest of the system was operating satisfactorily. The blockage seems to occur primarily

in the area of Mooring #2 and in the B-10 coring area.

26 Jan.-1100: Transited to site of Moor #6 and found reception from both stations was satisfactory. However, on returning with the ST-2154 to the pier it was found that there were a number of areas where navigation blacked out.

26 Jan.-1215: Despite work on navigation system it was found that there were still intermittent losses of signal and it was decided that transits should be set up as a back up. The ROICC arranged to borrow two transits from a contractor on Indian Island.

26 Jan.-1308: Installed a new crimp connector on the Mini-Ranger power supply which improved reception and proceeded out to place the marker buoys for Moor #6. The ranges were as follows from Kala Point and Crane Point:

	Ranges in Meters	
	Kala Point	Crane Point
Mooring Buoy Marker	1419	1505
Leg #1 Marker	1412	1641
Leg #2 - Outer Marker	1665	1409
Leg #2 - Inner Marker	1618	1419
Leg #3 - Inner Marker	1250	1392

It was necessary to lower the receiver/transmitter 3 feet in order to get any signals for Leg #3 and only the inner marker position could be fixed. The outer marker was lined up by eye from the center buoy and Marker #1.

26 Jan.-1615: Turned off transponder stations at Kala Point and Crane Point.

27 Jan.-0730: Used water transportation to get to Kala Point and to Crane Point in order to turn on transponders due to heavy snow on Island.

27 Jan.-0918: Transferred Mini-Ranger to LT-2076 and provided navigational fixes during the installation of Leg #1 of Moor #6 and the dropping of throw-off Legs #2 and #3.

27 Jan.-1235: Moved out to recheck position of center marker buoy and then continued to provide navigational fixes during the implantment of ground Leg #2 and ground leg #3 of Moor #6.

27 Jan.-1800: Secured Mini-Ranger and proceeded to Crane and Kala Points to shut down transponders.

28 Jan.-0745: FPO-1 departed for Crane Point to replace batteries so that old ones could be placed on charge.

28 Jan.-0830: Transferred Mini-Ranger to the ST-2154 in order to take fixes on Moor #6 marker buoys while CEL dived on anchors to verify that buoys had not moved.

28 Jan.-0945: Transferred Mini-Ranger to LT-2076 to provide navigational fixes as the legs of the moor were pulled into position.

28 Jan.-1320: Took a number of fixes on Mooring Buoy #6 and estimated the buoy to be only 6 meters off location. At this point the fathometer at the buoy read 80.2 feet below the keel.

28 Jan.-1330: Provided navigational fixes on Mooring Buoy #6 during the circle pull tests that were conducted prior to shortening riser. The initial plot of the watch circle showed a 50 foot displacement.

28 Jan.-1520: After the anchor legs of Moor #6 had been pulled to reposition the mooring buoy and remove slack in the chain, a number of passes were made at the mooring buoy with the following results:

Mag Heading	Kala Point	Crane Point	Side Buoy Passed On
315	1420	1494	Port
110	1411	1500	Port
230	1418	1502	Port
170	1413	1500	Port
305	1425	1493	Port

A line from the ST-2154 was then attached to the buoy and some pulling was done to attempt to move the anchor. However, no movement of the buoy was detected. The tug then returned to the pier after stopping off to shut down the transponders at Crane and Kala Points.

29 Jan.-0800: Proceeded to turn on transponders and ST-2154 moved out to make another position check on Mooring Buoy #6 with the following results:

Mag Heading	Kala Point	Crane Point	Side Buoy Passed On
315	1430	1495	Port
152	1422	1505	Port

A slight movement to the south of Mooring Buoy #6 was detected.

29 Jan.-1000: The ST-2154 then moved out to the mooring area to place the marker buoys for Moor #2. These markers were implanted in the positions indicated below:

	Ranges in Meters	
	Kala Point	Crane Point
Mooring Buoy Marker	1699	1919
Leg #1 Marker	1802	2055
Leg #2 - Inner Marker	1767	1756
Leg #2 - Outer Marker	1796	1734
Leg #3 - Inner Marker	1484	1924

This work was completed during the morning while the LT-2076 and the Crane Barge were in the process of shortening the riser chain on Moor #6.

29 Jan.-1230: The ST-2154 accompanied the other two vessels to the Moor #2 area to provide navigational data during the installation.

29 Jan.-1340: The signal from Crane Point was lost. FPO-1 went ashore to raise the Crane Point transponder three feet but the signal continued to be intermittent. Based upon this uncertainity the marker buoy for Leg #1 was repositioned by visual reference and Leg #1 of Moor #2 was laid and the two throwoff legs were dropped into the water.

29 Jan.-1600: While the other vessels returned to the pier, the ST-2154 continued to check positions of the marker buoy for Mooring Buoy #2 and also rechecked the location of Mooring Buoy #6. The tug then returned to shore and the transponders at Crane and Kala Points were turned off.

30 Jan.-0655: Turned on transponder at Kala Point and then transited to Crane Point to pick up old set of batteries. Transited out to mooring sites to check on position of Moor #2 center buoy marker. Found the marker was on location.

30 Jan.-0815: Provided navigation data to LT-2076 and Crane Barge during installation of Leg #2, Moor #2.

30 Jan.-0920: Ran over center marker of Moor #2 but navigation indicated it had returned to same location.

30 Jan.-0955: Provided navigation during attachment line to throwoff Leg #3 of Moor #2 and laying of ground leg.

30 Jan.-1035: Last crown line for Leg #3 of Moor #2 was dropped overboard and the #2 mooring buoy and its marker spar buoy were checked out as follows:

Buoy	Heading	Kala	Crane	Side	Offset
Spar	335	1706	1912	Port	3-5 m
Main	320	1699	1920	Stbd	4 m
Main	174	1704	1931	Port	4 m
Spar	222	1709	1917	Port	2-3 m
Spar	197	1709	1915	Stbd	7 m
Main	332	1700	1932	Stbd	3-4 m
Spar	198	1708	1913	Stbd	3 m

30 Jan.-1233: Transited to location of Mooring Buoy #2 and obtained the following data:

	Heading	Kala	Crane	Side	
	330	1710	1910	Port	+ 3 m
	155	1709	1915	Stbd	+ 3 m
Main	308	1699	1922	Stbd	

Based on these data Mooring Buoy #2 was moved to the following position:

Heading	Kala	Crane	Side
184	1706	1915	Stbd

Pulling on the anchor legs was continued until it was determined that Mooring Buoy #2 was in the correct location.

30 Jan.-1505: The LT-2076 hooked up to Mooring Buoy #2 for the pull test. Ran pull tests on Mooring Buoy #2 (prior to shortening riser) and obtained a 65 foot watch circle at a 12 kip load.

30 Jan.-1630: Returned to Mooring Buoy #6 to run an additional pull test. Difficulty was encountered in maintaining a constant 7 kip pull and about half way through the circle the signal from Kala Point died due to battery failure. Returned to pier.

31 Jan.-0710: Went to Kala Point to get angular fix of Mooring Buoy #2 and Mooring Buoy #6 using transits.

31 Jan.-0915: With the Mini-Ranger installed on the ST-2154, ranges were obtained from Mooring Buoy #6 as follows:

Kala	Crane
1416	1503
1415	1505

For these readings the receiver/transmitter was placed on the center of the buoy and held up using a boat hook. The ST-2154 then moved to Mooring #2 but could not get a response from Crane Point.

31 Jan.-0940: With the receiver/transmitter remounted on the ST-2154 the vessel transited to Mooring #6 and obtained the following readings:

Mag Heading	Kala	Crane
270	1433	1497
40	1414	1500
210	1433	1505
120	1421	1515

31 Jan.-1000: The LT-2076 then tied on to Mooring #6 to conduct pull tests with the ST-2154 assisting and providing navigational information. Tests were conducted in a full circle at 6 kips pull and then in a straight line at 12 kips pull bearing at 342° True and at 163° True. During these two straight line pulls, the fathometer reading was 76 feet from the keel.

31 Jan.-1130: Both tugs returned to the pier to bring out the Crane Barge for lifting and shortening the riser chain on Moor #2. The riser was shortened by 1235 at which point the fathometer read 70.3 feet below the keel.

31 Jan.-1235: The Mini-Ranger console was transferred to the ST-2154 for the installation of marker buoys for Mooring #1. After transiting to Moor #1 area it was found that the Mini-Ranger readings were unsatisfactory. The ST-2154 returned to the pier and installed an aluminum ladder secured to the mast to extend the height of the receiver/transmitter on the ship.

31 Jan.-1445: The ST-2154 got underway to set the marker buoys for Moor #1 and put in the center buoy and the marker buoys for Leg #1 at points designated as follows:

Positioning Center Buoy

Heading	Kala	Crane	Side	
285	1481	1983	Stbd	
282	1496	1981	Stbd	
213	1494	1971	Stbd	+ 9 on station

Placing Leg #1 Buoy

Heading	Kala	Crane	Side	
272	1557	1862	Stbd	+ 4
285	1545	1854	Stbd	+ 4
286	1549	1862	Stbd	+ 4
272	1539	1855	Stbd	+ 3
282	1547	1867	Stbd	+ 4

Due to a stiff breeze out of the northwest further marker buoy implantment was discontinued and the transponders at Crane Point and Kala Point were turned off after which the ST-2154 transited back to the pier.

31 Jan.-2000: Calculated distances and angles to points in Mooring #1 from Walan Point with back sight on Kala Point. Also wrote a program for the TI calculator to get range from any point on Kala or Crane with known range and angle from Walan with back sight on Kala. This permitted determination of all fixes required for Mooring #1 based on transit angles and Mini-Ranger distances from Walan Point.

1 Feb.-0830: Navigation set up for use with transit and Mini-Ranger from Walan Point for fixes required on #1 Moor. In addition a sighting rod was set up on Kala Point for back sights. The receiver/transmitter was installed at the bench marks on Walan Point and the transponder was installed on the 16 foot boat.

1 Feb.-0947: Established positions of Moor #1 center buoy marker and Leg #1 anchor buoy from Walan Point. Continued working with ST-2154 during the morning to establish marker buoys for Legs #2 and #3 of Moor #1.

1 Feb.-1000: After marker buoy positions were determined to be reasonably accurate navigation data were continuously supplied during the implantment of the first ground leg, mooring buoy, and second throwoff legs of Moor #1.

1 Feb.-1200: Continued supplying navigational data while ground leg #2 and ground leg #3 were installed.

1 Feb.-1310: Took additional fixes from Walan Point on Mooring Buoys #2 and #6. The range to Mooring Buoy #2 averaged 745 meters at a bearing of 41° 35 min and Mooring Buoy #6 was at an average range of 1227 meters at a bearing of 37° 06 min.

1 Feb.-1400: FPO-1 calculations on the Walan Point bearings and ranges indicated that Mooring Buoy #2 was 75 feet off station.

1 Feb.-1447: Ranges and bearings from Walan Point indicated that the Mooring Buoy #1 was off station and the tug moved it by pulling on the anchor legs to a point at range and bearing from Walan Point of 814 meters at 25° 22 min.

1 Feb.-1609: Measured all angles to all three mooring buoys from Walan Point with a back sight on Kala Point. The results were as follows:

Buoy	Angle
#6	37° 06 min
#2	41° 35 min
#1	25° 23.8 min

The angle to each mooring buoy was then measured from Kala Point with a back sight on Walan Point with the following results:

Buoy	Angle
#1	13° 44 min
#2	17° 11 min
#6	31° 39 min

1 Feb.-1900: FPO-1 attempted to ascertain the reasons for the apparent navigational errors. From the transit readings it appeared that Kala Point must be out in the water which indicated that at least one of the bench marks previously used had been in error.

2 Feb.-0745: Decided to use transits at Walan Point and a new bench mark called Cliff in order to locate and plot the three mooring buoys. The Cliff bench mark labelled I-55 was assumed found near the edge of the cliff. After taking sitings from the two transits on mooring buoys #1, #2, and #6 it was discovered that the stake, assumed to be I-55, was in error. See Figure A-7.

2 Feb.-0840: Called NOAA in Seattle to get information on the Coast and Geodetic Survey monuments at Kala Point. It was reported that the original Kala Point monument set up in 1920 was called Kuhn. This point was relocated in 1941 and called Kuhn #2. The Washington State and geographical coordinates of these two points are given below.

	Washington State Grid	Buoy	Angle
Cliff	E 1,534,593	#1	54° 53 min
	N 395,378	#2	58° 17 min
		$6	80° 31 min
	To Old Kala Point		65° 31 min

	Washington State Grid	Geographical
Kuhn	E 1,527,368.16	48° 03' 28.484" N
	N 391,829.07	122° 45' 58.222" W
Kuhn #2	E 1,527,417.25	48° 03' 28.853" N
	N 391,865.24	122° 45' 57.513" W

Kuhn #2 has two reference marks with bronze discs in 5 inch circular monuments. Also the real Cliff bench mark was located at the grid points below and the following angles were obtained using Walan Point as a back sight.

	Buoy	Angle
	#1	54° 53 min
	#2	58° 17 min
	#6	80° 19 min
To Old Kala Point		65° 31 min

In addition angles were taken from Walan using Cliff as a back sight with the following results:

Buoy	Angle
#1	70° 13 min
#2	54° 06 min
#6	58° 35 min

2 Feb.-1345: Located another monument at Kala Point which is a 4" x 4" square concrete monument with a brass screw in the center, and a square galvanized bolt in the northeast corner, and the letters U.S.E.D. on the south edge. A call to NOAA giving the description identified this as the 1920 Kuhn marker. The monument that had been used during all previous work, which had been assumed to be Kuhn, was not recorded by NOAA.

2 Feb.-1500: FPO-1 estimates indicated that the error might be as great as 320 feet but none of the angles seem to agree. At this point it was found that the zero reading from the Cliff monument at Walan was in error by 10° to the west due to using the reference point instead of the monument.

3 Feb.-0730: FPO-1 went aboard the LT-2076 to survey in the coordinates of Kala Point from Kuhn. The following Washington State Grid Coordinates were obtained for the three sites:

Kuhn	Walan	Kala	
E 1,527,368.16	E 1,532,462.09	E 1,527,584.39	(Army Corps of
N 391,829.07	397,069.82	391,817.13	Engineers Coordinates)

From these data the remaining errors in the system were resolved by taking transit sites and by surveying in the point where what had been called "Kala" was actually located. The calculated distance from Kuhn to what had been called Kala was 216.56 feet.

3 Feb.-1115: There being no more need for the transponder at Crane Point, FPO-1 disassembled the gear and returned it to the LT-2076.

3 Feb.-1350: The LT-2076 got underway to conduct circle pull tests on Mooring Buoy #1. At the start of the tests new angles were taken on the three mooring buoys from Walan and Cliff as follows:

Buoy	Walan	Cliff
#1	71° 17 min	54° 02 min
#2	54° 06 min	58° 15 min
#6	58° 35 min	80° 16 min

The tug was secured to Mooring Buoy #1 and a 6 kip load was applied as the tug circled around the buoy. For every 15° change of heading of the tug, angle readings were taken from Walan and Cliff. After this pull test it was then decided to run full 12 kip acceptance tests on all three mooring buoys.

3 Feb.-1430: The 12 kip pull acceptance tests on the three mooring buoys were conducted with transit angles being taken from Walan and from Cliff. The results are tabulated below:

Mooring Buoy #1

Pull	Walan	Cliff	Heading
1A	69° 38 min	55° 20 min	111.5°
1B	72° 35 min	52° 42 min	350°
1C	72° 38 min	53° 28 min	241°
1D	70° 40 min	55° 05 min	194°
	71° 04 min	54° 15 min	Final Buoy Location
			Fathometer Reading 76.7 feet

Mooring Buoy #2

Pull	Walan	Cliff	Heading
2A	53° 33 min	58° 58 min	137°
2B	53° 35 min	57° 51 min	048°
2C	54° 19 min	57° 23 min	351°
2D	54° 53 min	58° 08 min	256°
	54° 07 min	58° 12 min	Final Buoy Location
			Fathometer Reading 67.8 feet

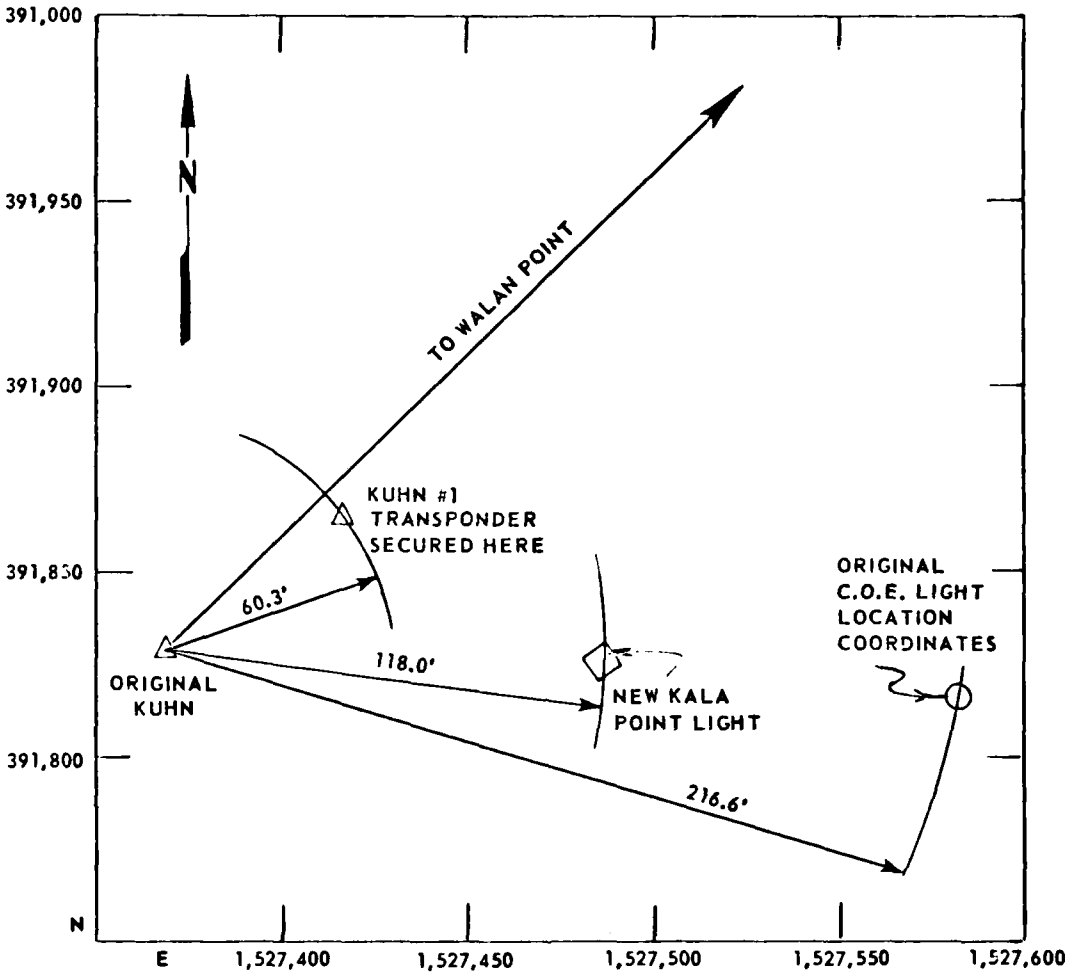
Mooring Buoy #6

Pull	Walan	Cliff	Heading
3A	58° 06 min	80° 40 min	103°
3B	58° 27 min	80° 05 min	035°
3C	58° 50 min	79° 45 min	346°
3D	59° 01 min	79° 53 min	273°
3E	58° 47 min	80° 22 min	209°
	58° 35 min	80° 15 min	Final Buoy Location
			Fathometer Reading 72.2 feet

4 Feb.-0820: FPO-1 returned to Kala Point to attempt to resolve earlier differences. The transit was set up on Kuhn and sitings were made on Walan and Cliff as well as to the point where the transponder had been located on Kala Point. Additionally, back sighting on Walan, the following angles were measured to the three mooring buoys:

Buoy	Angle
#1	13° 08 min
#2	17° 00 min
#6	31° 17 min

Distances were also measured from Kuhn to the Kala Point transponder site and from Kuhn to the new Kala Point Light. The locations of these various markers on Kala Point are shown in Figure A-6. This completed the on site navitation work for the Indian Island Mooring Project. These various discrepancies in location of markers at Kala Point were analyzed by FPO-1 and are resolved in a memorandum given in Appendix B.



IDENTIFICATION OF KALA POINT MARKERS

FIGURE A-6

BOTTOM CONDITION ASSESSMENT

The bottom conditions in the Indian Island mooring area were of particular interest to CEL based upon the results of the Shannon and Wilson Inc. investigation of 1975 and also their subbottom profiling report in January 1979. Because of this interest, CEL decided to conduct additional studies that would include both coring of the bottom in the mooring area and tests of the bottom sediments, as part of its Fleet Mooring Anchor Test Program.

22 Jan.-0830: The CEL truck arrived at the WSMC pier in Tacoma and unloaded the CEL and PMC equipment. The truck was due to arrive at Indian Island at 1900.

23 Jan.-0815: CEL started working on the Vibracorer to prepare it for continuing operations.

23 Jan.-1335: Set up Vibracorer on deck of ST-2154 and selected the first point for coring operations which was to be 1500 meters from Kala Point and 1800 meters from Crane Point. However, due to navigational difficulties, it was decided to move over to the existing mooring. The location of this point relative to other positions in the area is indicated in Figure A-7.

23 Jan.-1500: CEL diving gear was transferred to the ST-2154 and diving operations were begun for the purpose of inspecting the existing mooring.

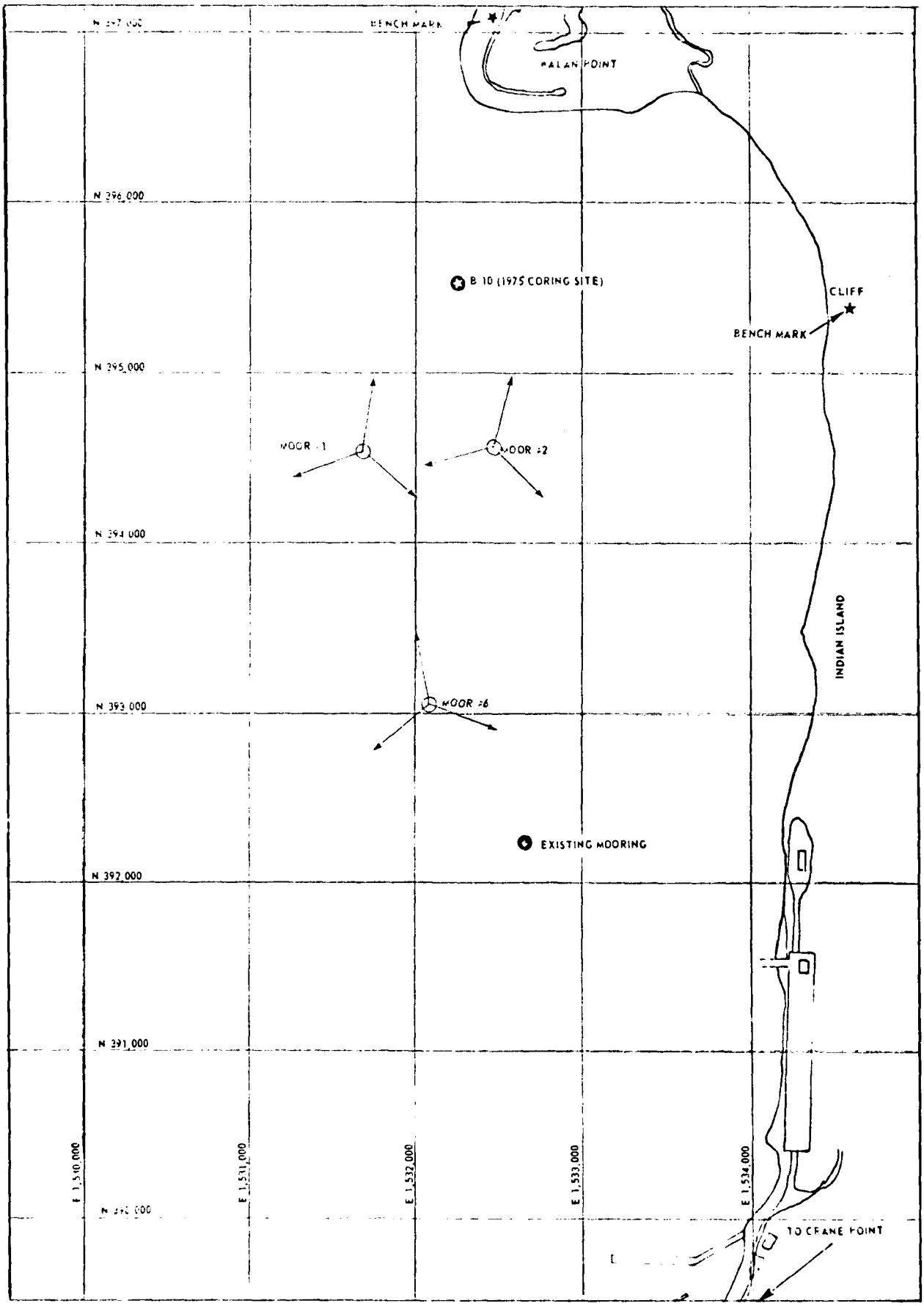
23 Jan.-1540: The CEL divers returned to the LT-2076 and described the existing mooring and the bottom around it as being of soft mud with ripples. A diver standing on the bottom sank into the mud and no ground tackle for the mooring was visible. The divers attempted a vane shear test, Figure A-8, and found that they could spin the vane into the bottom with no noticeable resistance and therefore never used the torque wrench to measure shear values. The penetrometer, when inserted into the bottom, sank to a depth of 6 feet without resistance and thus no readings could be obtained.

There was marine growth on the chain down to 40 feet from the surface but below that the chain appeared to be clear of growth and in good condition. The divers depth gage indicated a total water depth of 78 feet. At this point all personnel returned to shore.

24 Jan.-0910: Proceeded out to the previous coring station B-10 to do Vibracoring work aboard the ST-2154. The CEL spar buoy was also placed aboard. Due to navigational difficulties in locating site B-10, the ST-2154 returned to the pier.

24 Jan.-1307: The ST-2154 again got underway followed by the LT-2076 towing the BD-6650 Crane Barge with the Vibracorer aboard. Several attempts were made to hold the LT-2076 and Crane Barge on station with a 3,000 pound light weight anchor but the vessels continued to drift and drag anchor. Eventually, at 1445, the ST-2154 attempted to control the drift of the Crane Barge by pushing on the stern and, after holding location for about two minutes, it was decided to put the Vibracorer over the side, Figure A-9.

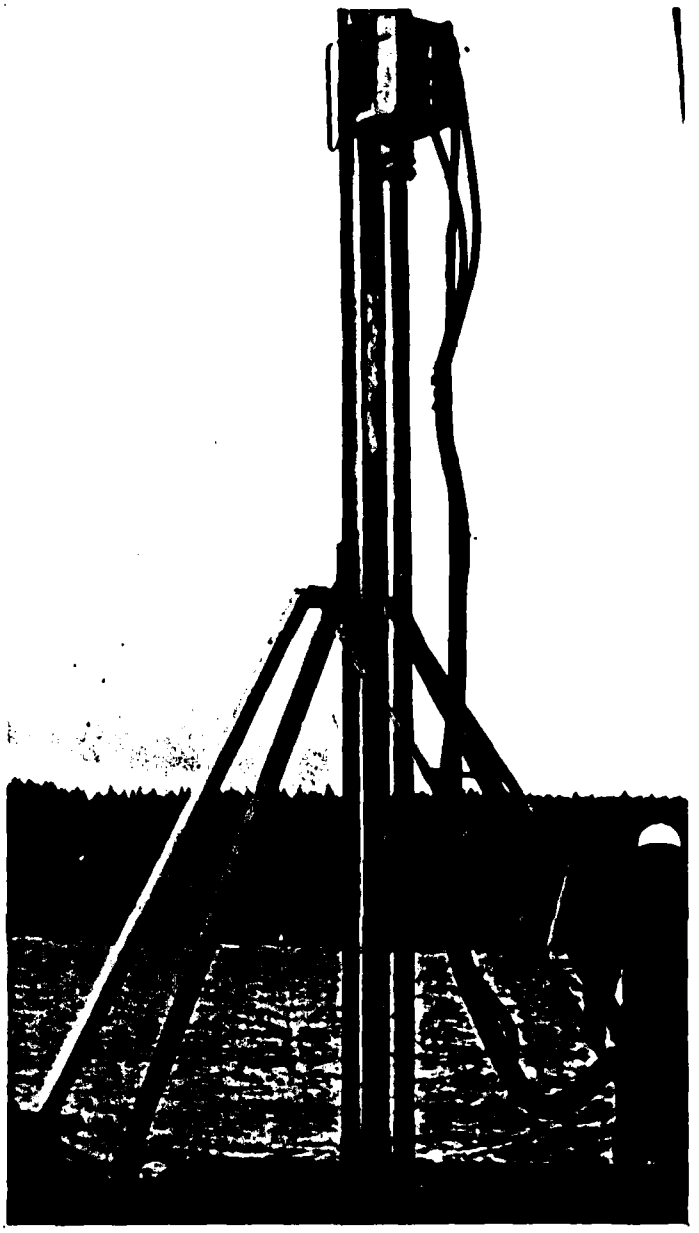
24 Jan.-1521: After a very rapid penetration into the bottom, the Vibracorer was hauled back on deck with about 17 foot of core. It was then decided to return to the existing mooring to obtain another core.



JUXTAPOSITION OF RELEVANT ELEMENTS IN MOORING AREA

FIGURE A-7

SHEAR VANE
FIGURE A-8:



VIBRACORER
FIGURE A-9

24 Jan.-1540: The LT-2076 tied up to the existing mooring and the Vibracorer was lowered into the water. CEL divers went down to obtain visual evidence that the Vibracorer was resting on the bottom after which they reported that although standing divers sank about 3 inches into the mud the Vibracorer pads still rested on top of the bottom

24 Jan.-1600: After reports from the divers, and some problem starting the Vibracorer air compressor, a core was obtained.

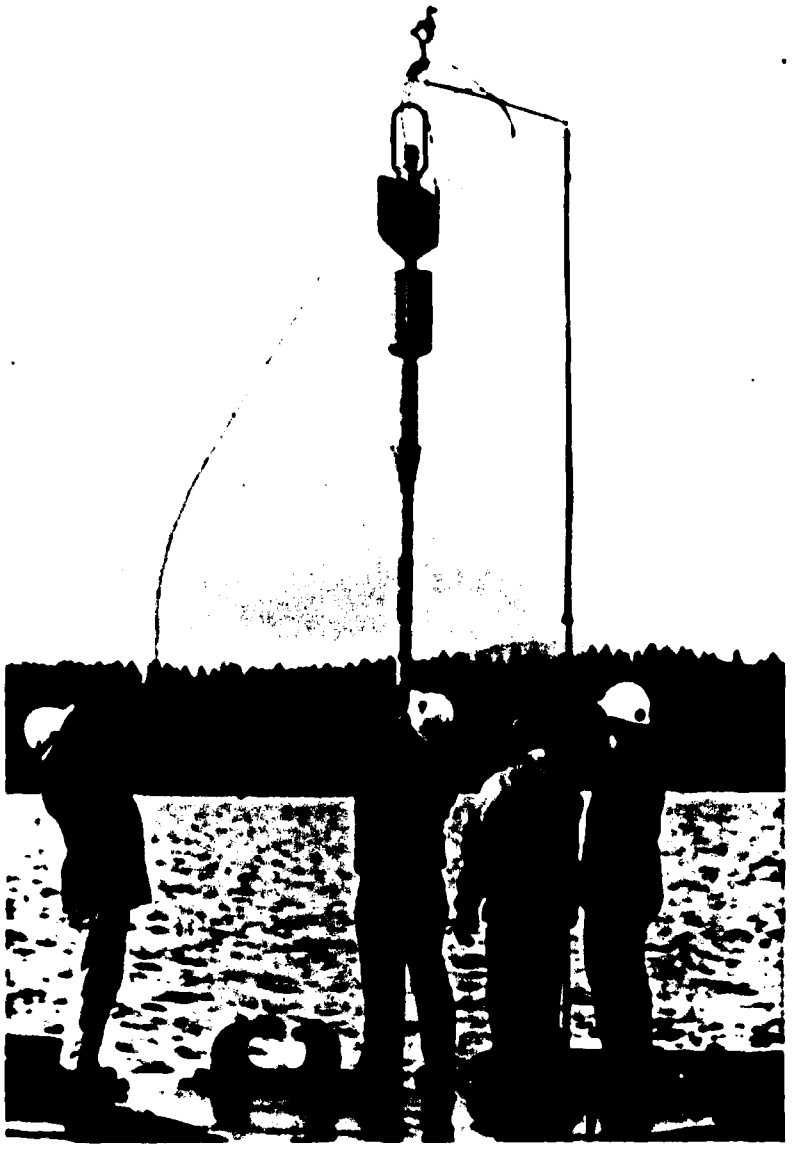


FIGURE A-10: PISTON CORER

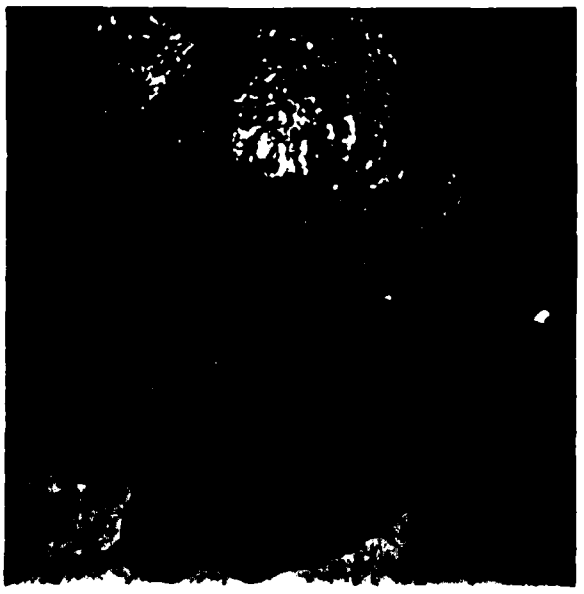


FIGURE A-11: END OF CORE BARREL

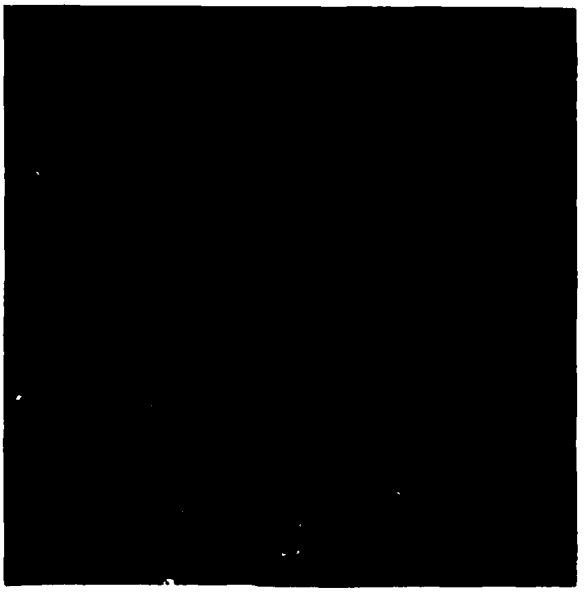


FIGURE A-12: BOTTOM SAMPLE

24 Jan.-1620: The core obtained from a very rapid penetration into the bottom was hoisted on deck and found to be about 15 feet in length. It is interesting to note that after being on deck for about one hour the core sample expanded out of the core tube due to expanding gas within the sample.

25 Jan.-0805: Decided to proceed again to site B-10 to obtain a core sample. It was concluded that an 18 kip anchor was required to hold the Crane Barge BD-6650 on station. As a result of this effort, Vibracoring was accomplished at sites PSII #1, #2, #3, and #4 at the locations specified in the previous section. Piston cores as well as Vibracores were obtained at sites #3 and #4. Figure A-10 is the piston corer and Figures A-11 and A-12 are bottom samples.

25 Jan.-1355: By this point all cores required had been taken and all five samples appeared similar so that the decision was made that no other samples would be required.

25 Jan.-1440: All coring gear was cleaned and packed.

26 Jan.-0820: Packing of coring gear for return was completed.

SUPPLEMENTARY WORK ON EXISTING MOORING

The relationship of the old mooring to the new Indian Island moorings is illustrated in Figure A-7. This existing mooring served as a focal point for a number of construction operations and for the bottom sampling as noted in the previous section. It was also used for practice pull tests and then was finally removed from the area as described in the following chronology of events:

24 Jan.-0945: FPO-1 received a call from WESTDIV relative to the inspection of the existing mooring while the CEL divers were in the area. The possibility of recovering the old mooring was also discussed.

26 Jan.-0800: After turning on and adjusting navigation gear at Crane Point and Kala Point the LT-2076 made ready to conduct pull tests on the existing mooring while the Crane Barge was being rigged for the afternoon implantment.

26 Jan.-0840: The tow line at the stern of the LT-2076 was rigged for the towing tests but there was some delay getting underway due to navigation problems and the need to use the tug to move one of the YC storage barges.

26 Jan.-0945: The LT-2076 left the pier, arrived at the buoy and hooked up to the buoy with a nylon tow line. When the first pull was started the strong winds out of the southeast caused a drifting of the tug which applied a snap

load of 6 kips to the tow line where it reached maximum extension.

26 Jan.-1005: Pulling around to the north with the wind on the stern the load held steady at 12 kips with the propeller turning slow ahead at 160 rpm.

26 Jan.-1025: The pull test circle was started with some loss of pull due to rudder action. The mooring circle radius was approximated at 75 feet. Here the pull test was terminated and the LT-2076 returned to the pier satisfied that the pull test technique was satisfactory.

2 Feb.-0815: FPO-1 received a call from NUWES giving them the go ahead to recover the existing mooring for refurbishment with cost adjustments to be made at a later date. FPO-1 was to recover the mooring and place it aboard one of the YC barges.

2 Feb.-0855: FPO-1 discussed with PWC what would be required in the recovery of the existing mooring installed sometime about 1965. PWC requested that CEL conduct an initial diver inspection of the mooring and then a second diver inspection after the buoy had been lifted and the ground tackle exposed. High pressure water was unavailable to wash down the buoy and chain during recovery and it would be necessary to yo-yo the crane in order to bring up the amount of chain involved.

2 Feb.-0920: The LT-2076 with the Crane Barge BD-6650 departed the pier, approached the existing buoy, and tied up to it with the #1 hook of the crane. The buoy was lifted 40 feet into the air and the #2 crane hook was secured to the chain. The riser was secured to the barge deck to permit diver operations.

2 Feb.-0955: The CEL diver inspection indicated that the ground ring was connected to a clump buried in the bottom by a wire rope which it was necessary to cut before lifting the ground ring and anchor chains. As can be seen in Figure 13 the ground ring was shackled to the 3 anchor legs, to the riser, and to the wire rope connection to the clump. Meanwhile, the buoy had been unhooked from the crane and placed on deck and hauling of the riser aboard the Crane Barge continued with the legs being stoppered off on deck as the ground ring came aboard.

2 Feb.-1020: The two north legs of the moor were cut off, lines and a buoy attached, and then dropped overboard for later recovery.

2 Feb.-1045: The south anchor leg was then pulled aboard with the caked mud on the chain being washed off and the anchor finally brought aboard. It was

FIGURE A-13: CHAIN, SHACKLES, AND GROUND RING

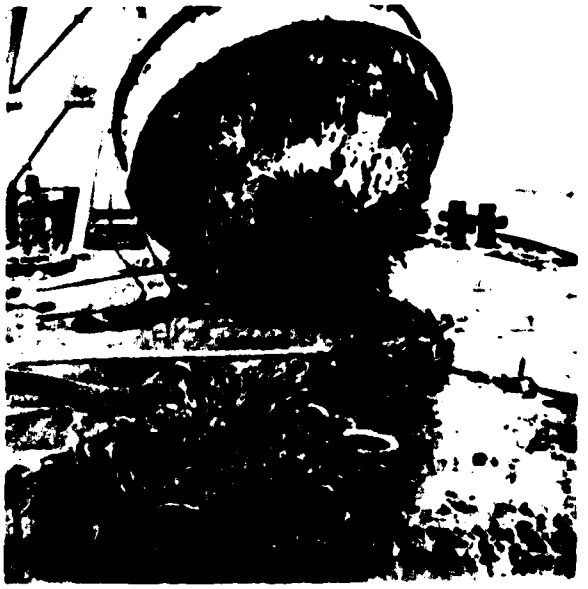


FIGURE A-14: BUOY ON CRANE BARGE DECK

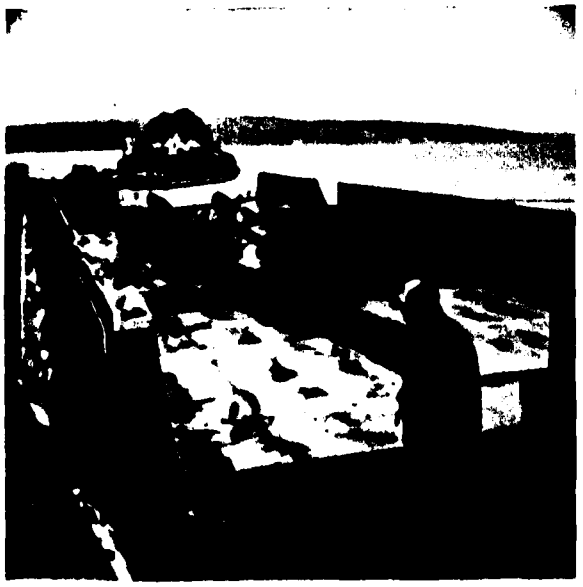


FIGURE A-15: BUOY, CHAIN, AND ANCHORS TRANSFERRED TO YC AND HOSED DOWN

FIGURE A-16: CHAIN WITH MARINE GROWTH BUT MINIMAL CORROSION

estimated that there were four shots of chain in the south anchor leg and that the shots were shackled together. Using the Crane Barge windlass and a nylon rope the anchor was dragged to the port side of the Crane Barge deck.

2 Feb.-1150: The Crane Barge was secured to the remaining two anchor lines and the ST-2154 was sent ashore for additional line to pick up the mooring. In the meantime the Crane Barge deck was hosed down to clear it of the debris deposited by the south ground leg.

2 Feb.-1205: The ST-2154 returned and recovery started again. One ground leg was cut loose and put overboard with a pick up buoy and hauling on the second ground leg was started. The anchor was hauled on board the Crane Barge and the anchor and chain for this second ground leg were stowed on deck.

2 Feb.-1255: Moved over to pick up buoy and start retrieval of the third ground leg. Continued picking up chain and kiting on hook #1 of the crane.

2 Feb.-1330: The last anchor came out of the water and was stoppered off at the deck. The tug and Crane Barge then headed back for the pier.

2 Feb.-1345: A counting indicated that there were seven 45 foot shots (315 feet) per ground leg. There was extensive marine growth on the bottom of the buoy and on the upper 45 feet of riser chain as shown in Figure A-14.

2 Feb.-1400: All of the mooring components were transferred from the Crane Barge to the YC storage barge as illustrated in Figure A-15. The chain Figure A-16, was 1 1/2 inch stud link which was reasonably well preserved due to being sunk in the mud. The anchors were in the range of 5 to 8 kips. The ground ring was 2 3/4 inch wire and 2 inch bending shackles were used in the legs and riser to tie together each 45 foot section of chain. This completed the recovery of the old mooring.

MOORING SYSTEMS PREPARATIONS ON CRANE BARGE

22 Jan.-0830: The CEL truck arrived at the WSMC pier in Tacoma and the material aboard was transferrred from the truck to the Crane Barge BD-6650. The LT-2076 took the Crane Barge in tow and arrived at Indian Island at 1938. In the meantime, CEL personnel transited to NUWES Keyport to pick up an air compressor and a welding machine.

23 Jan.-0800: PWC began examining the mooring components on board the YC-1073

and the YC-1107 at Indian Island. With the assistance of the Crane Barge BD-6650 the hardware was moved around the deck to permit making a more efficient inventory.

23 Jan.-0900: The YC-1073 and YC-1107 were moved around to the north side of the pier for unloading and the Crane Barge started shifting chain around on the barge deck to facilitate the inventory.

23 Jan.-1000: Chain aboard the YC-1073 was moved to the point where all three ground rings were free and available for transfer.

23 Jan.-1045: PWC gear box was being unloaded and transferred aboard the BD-6650.

23 Jan.-1105: It was discovered that one of anchors was missing a shackle to the jews harp.

At this point it should be mentioned that previous tests on the consistency of the bottom in the mooring area off Indian Island had indicated that normal anchor lowering and pulling into position might not be satisfactory. It had been decided that the Navy Stockless anchor flukes should be welded in an open position and that a bridle should be used for lowering the anchors from the crane in such a way that the flukes would sink directly into the bottom sediment oriented so that they would be installed in a position of maximum pulling force. The bridle system used for lowering should be such that, when pulling on the anchor crown, the flukes would remain pointed downward, and thus drop into a holding position in the bottom. The arrangment should be such that if the anchor were pulled horizontally by the crown or by the shank, the anchor would remain in a horizontal position with the flukes locked into the bottom. The bridle system is shown in Figure A-17 and the holding link is shown in Figure A-18. This was devised by PWC in such a manner that the application of a significant horizontal force either on the jews harp or on the crown would break the fabricated link.

23 Jan.-1110: Anchors were moved on the deck of YC-1107 and wood blocks placed under the flukes in order to position them for welding in the open position. During the day considerable trouble was experienced in welding the anchors in the open position. Although an apparently satisfactory weld was achieved a slight blow of a sledge hammer would break the weld open.

FIGURE A-17: ANCHOR RIGGED WITH BRIDLE FOR LOWERING OVERBOARD

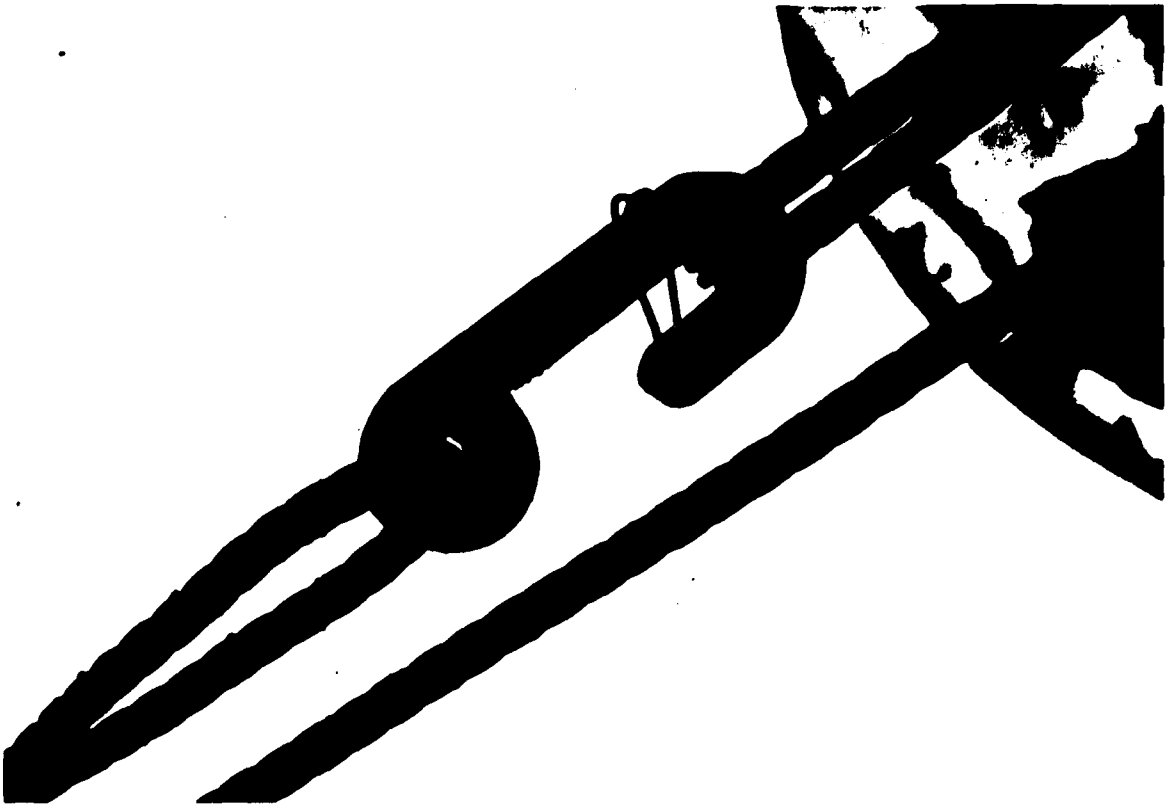


FIGURE A-18: DETACHABLE OR BREAKAWAY ELEMENT OF BRIDLE

24 Jan.-0835: A telephone call to CEL established the fact that the weld rods used were for an AC welder whereas the welder borrowed from NUWES was a DC welder and therefore low hydrogen rods were required. An arrangement was made with NUWES Keyport to trade welding rods.

25 Jan.-0800: Using the replacement welding rods the anchors were moved around aboard the YC-1107 to position them so that wedges could be welded in to hold them in the open position and the anchor jewelry was attached and measured. A typical example of flukes in the welded open position are shown in Figure A-19 and typical anchor jewelry is shown in Figures A-20, A-21, and A-22. Some trouble was experienced with tight joints on the anchor for Leg #3 Moor #2 but these difficulties were resolved.

25 Jan.-1530: By this time all three anchors for Moor #6 had been transferred aboard the Crane Barge.

26 Jan.-0800: The entire day was spent rigging the deck of the Crane Barge for the installation of Mooring #6. Throwoff Leg #2 was assembled and hung off the port side of the BD-6650. The end of the leg was tied to a cleat at the bow and tricing lines were secured along the port side rails, chocks, and cleats. This throwoff leg comprised three shots of chain with the last several feet of the third shot stowed on the deck of the Crane Barge.

26 Jan.-1000: Prepared throwoff Leg #3 for Mooring #6 by hanging the chain over the bow in a manner similar to that used for throwoff Leg #2 on the port side; again the last several feet of throwoff Leg #3 were stowed on deck, Figure A-23.

26 Jan.-1120: At this point PWC had uncovered a number of chain connectors aboard the YC-1073 that were in very unsatisfactory condition, missing pins and not refurbished. Fortunately, sufficient equipment had been brought along by PWC which could be substituted.

26 Jan.-1130: The ground ring assembly for Moor #6 was moved into position on the deck of the Crane Barge. This comprised a 4 inch ground ring with four 4-2 1/2 inch anchor joining links attached to which were to be connected the three ground legs and the riser. This assembly is illustrated in Figure A-24.

26 Jan.-1140: Next, the riser chain for Moor #6 was prepared. This preparation included lifting an entire shot of 2 1/2 inch chain, measuring off a 40 foot length, and cutting. The parted ends of the shot of chain were then rejoined

FIGURE A-19: WELDED WEDGE HOLDING ANCHOR IN OPEN POSITION

FIGURE A-20: TYPICAL ANCHOR JEWELRY

FIGURE A-21: TYPICAL ANCHOR JEWELRY

FIGURE A-22: TYPICAL ANCHOR JEWELRY

using a detachable link to provide for removal and raising of the ground ring at a later point in the installation. This reassembled shot of chain was then raised another 10 feet and again cut off and attached to a 25 foot swivel shot using a detachable link. Then an anchor joining link was used to attach the end to the ground ring.

26 Jan.-1340: Ground Leg #1 of Moor #6 was then assembled. This consisted of lifting a 45 foot one-half shot of 2 1/4 inch chain from the storage barge and joining it to a swivel shot which was connected to the Leg #1 anchor with a detachable link (see Figure A-21). This chain was laid out on deck and a full shot of chain was connected to it and faked out on the deck alongside the riser chain. This process was repeated with a second, third, and fourth shot of chain, the last of which was attached to the anchor joining the link on the ground ring, thus completing the assembly of Leg #1 and the riser.

26 Jan.-1515: Two shots of chain were lifted from the storage barge and laid on the deck in clumps near the anchors for Leg #2 and Leg #3 of Moor #6. The layout at this point is shown in Figure A-25.

26 Jan.-1525: Mooring Buoy #6 was lifted from the storage barge using the main hook from the Crane Barge and hung a short distance above the deck. To the jewelry under the buoy was attached the end of the riser chain. The buoy was then lifted and deposited on the deck of the Crane Barge. In addition a crown line and crown buoy were rigged to the Leg #1 anchor.

27 Jan.-0800: Assembly of Leg #1 crown line for Moor #6 was then completed by tying the crown line to a cleat, fastening a bridle in the crown line, applying a test pull at the crown line, and attaching peanut floats to it. At this point all of the equipment required for Moor #6 was laid out aboard the Crane Barge and ready for implantment.

27 Jan.-1800: By this time the Crane Barge had completed its role in the installation of Moor #6 (to be described in a following section) and had returned to the pier on Indian Island.

28 Jan.-0800: The riggers from PWC began preparing the deck of the Crane Barge for loading the equipment for the installation of the second mooring, Moor #2. This work essentially followed the same pattern as described for Moor #6 with an identical riser assembly but with some variations in length of the throwoff legs and ground legs to accommodate the available lengths of chain.

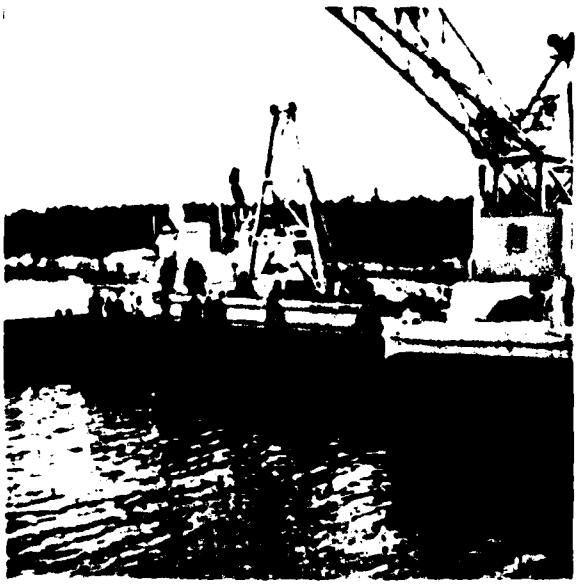


FIGURE A-23: THROWOFF LEG ON SIDE OF BARGE

FIGURE A-24: GROUND RING WITH LINKS

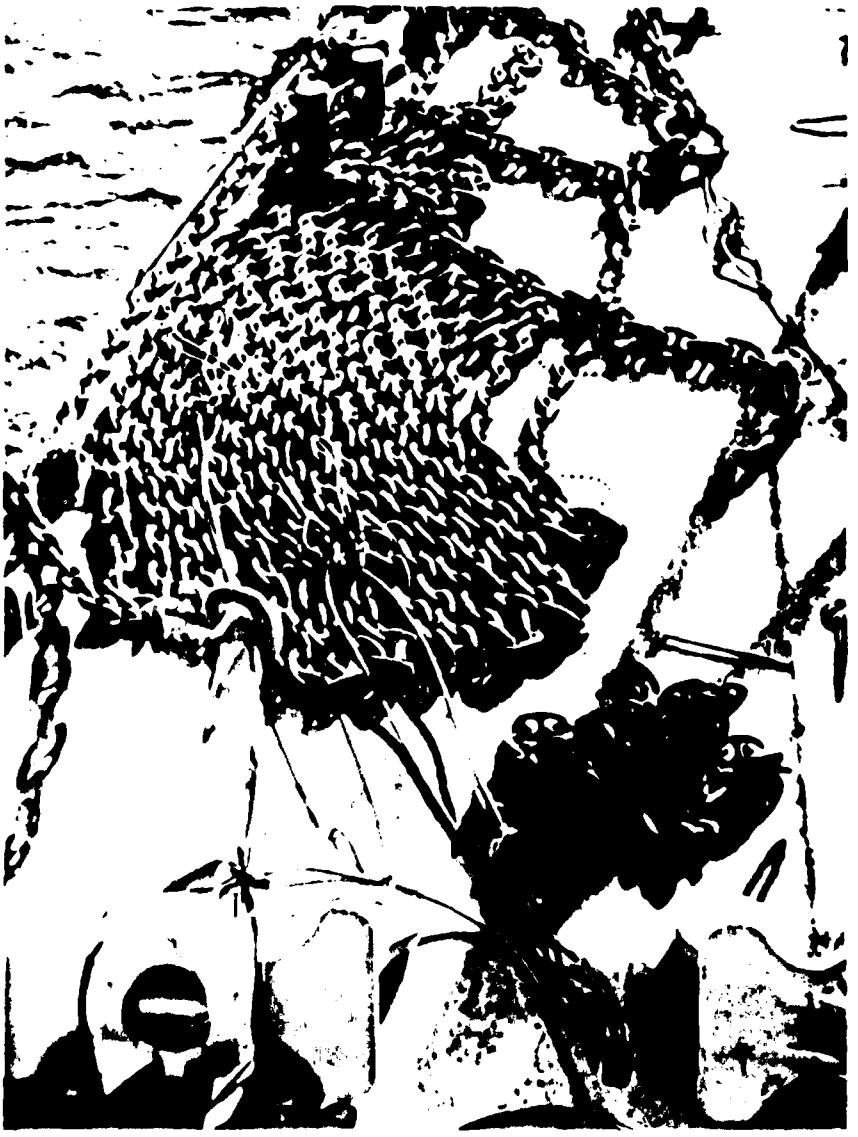


FIGURE A-25: MOOR #6 LAID OUT ON CRANE BARGE DECK

29 Jan.-1025: The Crane Barge deck layout for Moor #2 was essentially completed and, in addition, a few extra shots of chain for Moor #1 were also brought aboard. At this point, the Crane Barge departed to shorten the riser on Moor #6 and to start the implantment of Moor #2

29 Jan.-1600: The Crane Barge returned to the pier after having implanted Leg #1 and throwoff legs #2 and #3 of Moor #2. At the pier the rigging for the next ground leg was started aboard the Crane Barge.

30 Jan.-0730: The rigging on deck completed, the Crane Barge then returned to the mooring site to complete the installation of Moor #2. The deck rigging work for the third ground leg was accomplished while the barge was out on station.

30 Jan.-1120: The Crane Barge returned to the pier and began rigging for the installation of the last moor, Moor #1 which was accomplished in the same manner as for the two previous moors.

31 Jan.-0730: The rigging for Moor #1 continued aboard the deck of the Crane Barge. A defective chain link was encountered as the chain was laid out on deck and some time was lost while the defective link was cut out and replaced with a connecting link.

31 Jan.-1140: The rigging work on deck was again interrupted so that the barge might be used for shortening the riser chain on Moor #2.

31 Jan.-1400: The Crane Barge returned to the pier and rigging for Moor #1 continued.

1 Feb.-0830: Rigging for Moor #1 on the deck of the Crane Barge was completed. Again the rigging was similar to that used for the two previous moors except that, since the Moor #1 anchors were 20 kips versus 18 kips for the other two moors, the anchor handling rigging bridle system was altered somewhat.

The Crane Barge deck rigging for Moor #2 is shown in Figure A-26 and that for Moor #1 is shown in Figure A-27. Figure A-28 illustrates the arrangement of the Crane Barge BD-6650, the two storage barges YC-1073 and YC-1107, and the small tug ST-2154 during the period when the gear for each mooring was being transferred from the storage barges to the Crane Barge.

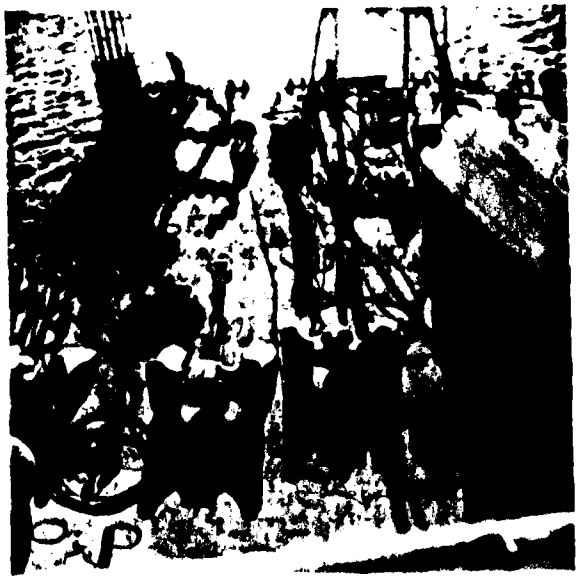


FIGURE A-26: COMPONENTS OF MOOR #2

FIGURE A-27: COMPONENTS OF MOOR #1

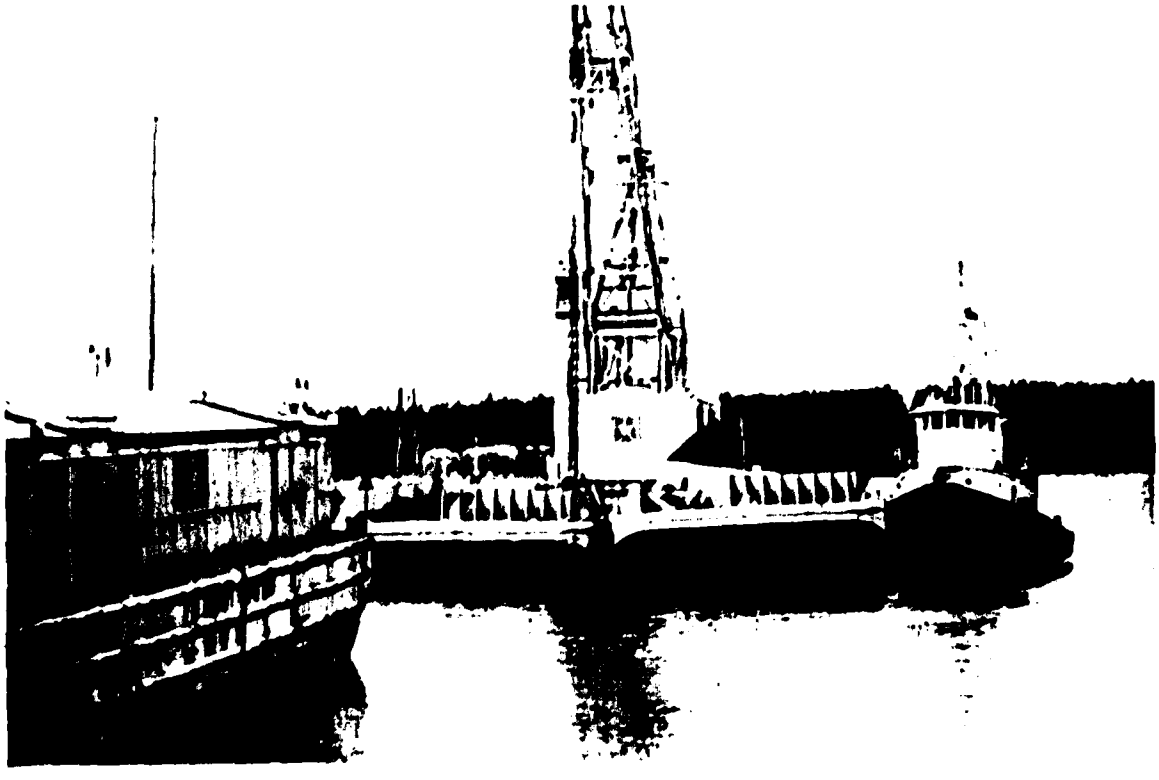


FIGURE A-28: YC STORAGE BARGES, CRANE BARGE, AND SMALL TUG DURING TRANSFER OF COMPONENTS TO CRANE BARGE DECK

MOORING INSTALLATION AND TESTING

As in the previous section on mooring system preparation aboard the Crane Barge a detailed chronological account will be given of the installation of the first of the new Indian Island moorings, Moor #6, and then a general time schedule will be given for the installation of the two moorings, Moor #2 and Moor #1.

27 Jan.-1042: The tug LT-2076 with the Crane Barge BD-6650 in tow departed the pier to install Moor #6 after having briefed the CEL divers on how to release the anchor bridles and after ensuring that the navigational system was in working order.

27 Jan.-1110: Upon reaching the location of the anchor marker buoy for Leg #1 of Moor #6 the crane was attached to a snatch block through which the crown line was reeved and the anchor was lowered to the bottom. The crown buoy had previously been secured to the other end of the crown line. After the anchor reached the bottom the snatch block was removed from the hook and the crown buoy was over boarded.

27 Jan.-1135: PWC, using a burning torch, cut the wire rope holding the Leg #1 anchor chain and the 130 feet of chain to the first stopper dropped overboard off the port bow. The LT-2076 then proceeded to tow the Crane Barge toward the center marker of the moor. During the transit the second chain stopper was released and all of anchor Leg #1 up to the ground ring was dropped into the water as the Crane Barge moved toward the center point of the moor.

27 Jan.-1148: At this point Mooring Buoy #6 was connected to the crane, lifted, and lowered into the water.

27 Jan.-1203: The stopper holding the ground ring was released and the riser chain (to which Leg #1 and the mooring buoy were attached) was dropped into the water.

27 Jan.-1204: At this point both throwoff legs were dropped into the water with buoys attached for their retrieval. Figure A-29 shows the Crane Barge BD-6650 lashed to the large tug LT-2076 and the small tug ST-2154 as it was used during these operations. Figure A-30 shows the anchor and crown buoy about to be lowered overboard and Figure A-31 shows the mooring buoy prior to lifting into the water.

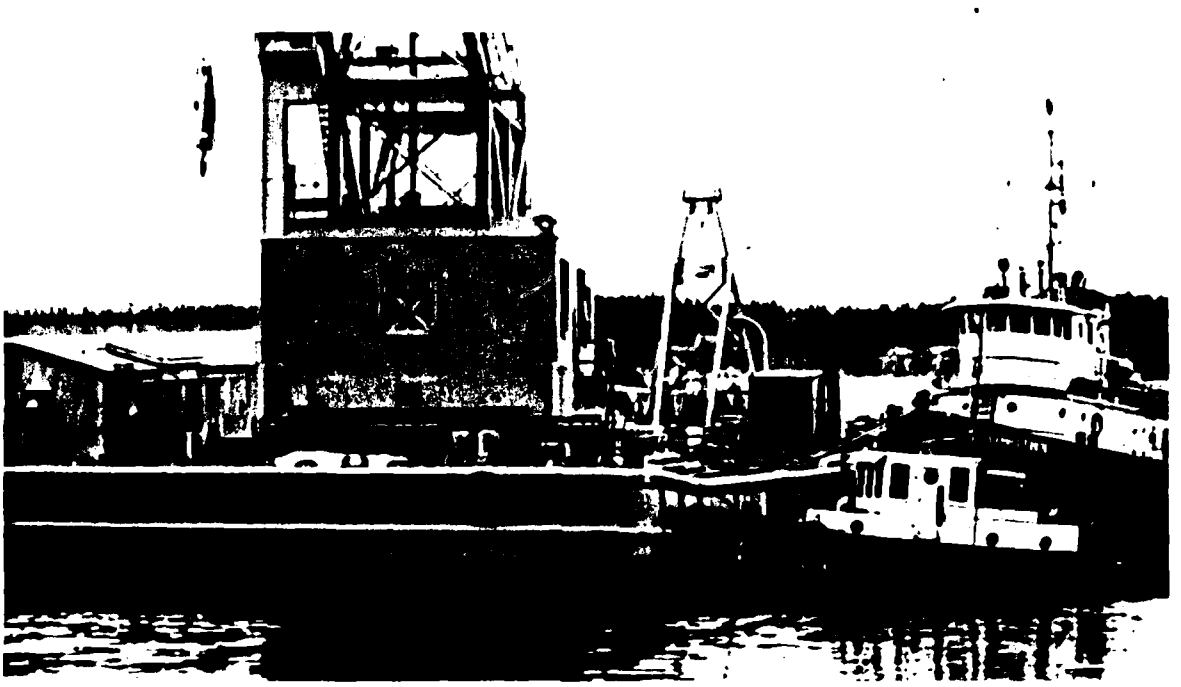


FIGURE A-29: THE SMALL TUG, ST-2154 AND THE LARGE TUG, ST-2076 SECURED ALONGSIDE THE CRANE BARGE

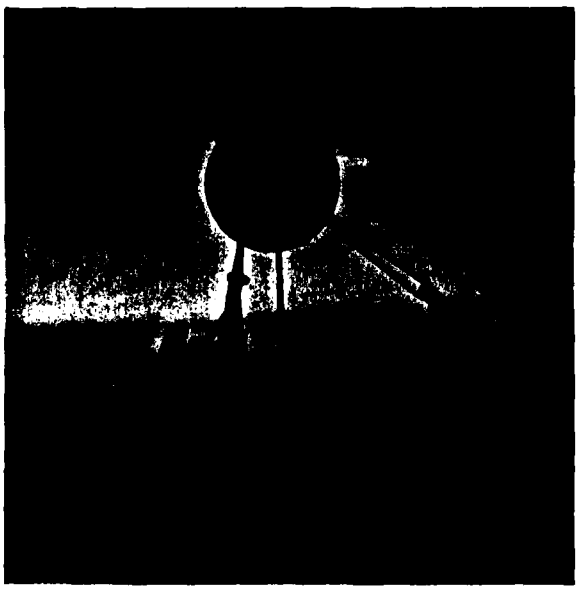


FIGURE A-30: ANCHOR AND CROWN BUOY READY FOR LOWERING

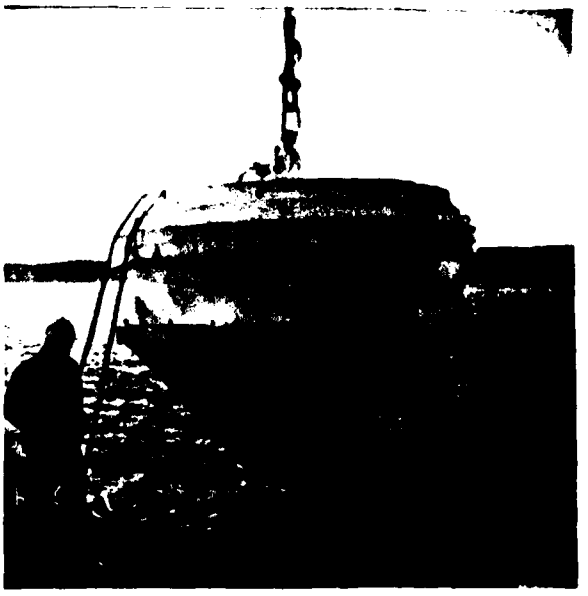


FIGURE A-31: MOORING BUOY BEING HOISTED TO BE PUT IN WATER

27 Jan.-1215: The next hour was spent in rerigging the deck for laying the remaining two ground legs. This consisted of moving the anchor into position, attaching 45 feet of chain, plus a 25 foot swivel shot, and then attaching a full shot of chain with the connecting link. Chain stoppers were attached, the bridle was rigged on the anchor, and the crown line and crown buoy were rigged ready for overboarding. Leg #3 was layed out for subsequent rigging.

27 Jan.-1320: The LT-2076 started moving the Crane Barge over into position to pick up the buoy on throwoff Leg #2. This required considerable maneuvering to get into a position relative to the float where it could be snared and brought aboard.

27 Jan.-1355: The float was lifted onto the deck of the Crane Barge and the attached line hauled in and looped over a cleat. The throwoff leg was then brought aboard, stopped off on deck, and the end connected to ground Leg #2.

27 Jan.-1430: The snatch block was again attached to the crane hook and the crown line from anchor #2 was reeved through it. Concurrently the Crane Barge had been maneuvered away from the moor center marker toward the range markers. Anchor #2 was then lowered into the water and chain stoppers were released so that the anchor and its crown line could descend to the bottom. The crown buoy was then pushed into the water completing the overboarding of the second leg of Moor #6.

27 Jan.-1445: During the next 35 minutes the deck of the Crane Barge was rerigged for overboarding the third ground leg of Moor #6. Again this included attaching a bridle to the anchor, connecting 45 feet of chain to the swivel shot, and connecting a full shot of chain to the remainder. The crown line was run through the snatch block and the crown buoy attached.

27 Jan.-1535: CEL divers moved out on the ST-2154 to rig a pick up wire below a possibly damaged section of throwoff Leg #3.

27 Jan.-1610: The large tug with the Crane Barge in tow again moved over to the position of the Leg #3 crown buoy and after some difficulty secured it for bringing on board. By this time the pick up line was fouled in the chain and PWC decided to rig a new pick up line.

27 Jan.-1720: The pickup buoy was recovered and put aboard the deck of the Crane Barge.

27 Jan.-1730: Ground Leg #3 was connected and installed in the same manner as ground Leg #2.

27 Jan.-1750: The anchor for ground Leg #3 was on the bottom, the crown line and buoy in place, and the tug and barge returned to the pier. At this point all components of mooring system #6 were in the water.

28 Jan.-0830: The ST-2154 with CEL divers aboard departed to dive on the three crown lines of Moor #6 to check out the anchor positions on the bottom.

28 Jan.-0945: The tug returned to the pier after the divers had checked out the first two anchors. The anchors were at least 6 feet down into the mud and they were unable to release the bridle hook device. The depth of the anchors had been verified by using an 8 foot probe. It was assumed that the third anchor was in the same condition. The ground ring was reported to be about one foot off the bottom.

28 Jan.-1000: A pendant was attached to the LT-2076 and the tug departed to take the slack out of the ground legs and reposition the buoys.

28 Jan.-1030: The tug came alongside the crown buoy for the anchor on Leg #2, hooked up to the buoy and started to pull in the direction of the two Leg #2 marker buoys. During this period it was difficult to maintain a direct line over the stern to the crown buoy and the ST-2154 was brought alongside the LT-2076 to provide direction control. With this assistance the LT-2076 propeller was brought up to 270 rpm at which point the mooring buoy tilted and moved rapidly toward the tugs indicating that both anchor and chain had moved.

28 Jan.-1147: The two tugs moved around to the crown buoy for Leg #1 and pulled north to take slack out of the ground chain. As pull was applied the lines suddenly jumped but there was not obvious movement of the buoy. However, it was postulated that the hook on the anchor bridle had broken loose and that the anchor was actually being moved along the bottom.

28 Jan.-1250: The tugs then moved around to the Leg #3 crown buoy, tied up to it, and began to pull in the direction of the marker buoys. When the large tug reached 210 rpm the line again jumped indicating that the anchor was being moved. At this point it was estimated that the Mooring Buoy #6 was only six meters off location.

28 Jan.-1330: The next scheduled exercise was a circle pull test on Mooring Buoy #6 prior to shortening the riser. Approximately 130 feet of line was used from the stern of the tug to the eye on the mooring buoy. A tension of 12 kips was applied as the LT-2076 moved around the buoy in a circle. However,

it was found that the dynamometer needle was jumping considerably, apparently due to the propeller race impinging on the mooring buoy. Therefore additional line was added and the pull test circle was rerun. Prior to the pull test the buoy had been submerged with the waterline about one inch above the bottom fender. After the pull tests the buoy freeboard increased considerably indicating that the chains straightened out to the extent that the ground ring was on the bottom and that the buoy was no longer supporting any weight of the ground legs.

28 Jan.-1455: At this point the marker buoys were recovered and an initial plot was made of the watch circle showing a 50 ft buoy displacement under a 12 kip load. It was then planned to apply additional pull to Anchor Leg #2 in order to center the mooring buoy more closely on station. This attempt was made with the ST-2154 but the buoy did not move indicating the anchor legs were pulled taut.

29 Jan.-0800: The CEL divers proceeded out on the ST-2154 to dive on the anchors of Moor #6 and to recover the center marker buoy which had been pulled down by the riser chain during the operation. They reported that, at this point, the ground ring was three feet off the bottom. (It may be noted that at 0800 the tidal height relative to mean low low water was plus 8 feet which would tend to lift the buoy and pick up the ground ring.)

29 Jan.-1020: The LT-2076 with the Crane Barge in tow transited out to Mooring Buoy #6 to shorten the riser chain. The lift line was attached to the buoy and the buoy lifted more than 40 ft as shown in Figure A-32. The riser was tied to a cleat with a wire rope and then the 40 foot portion of riser chain to be removed was disconnected and the buoy reconnected to the shortened riser. The buoy was lowered back down into the water, Figure A-33, and a dynamometer inserted in the lifting line, Figure A-34. The buoy was again lifted out of the water with the dynamometer in the line and a reading of 28.5 kips was obtained.

29 Jan.-1220: This completed the installation aspects of Moor #6 leaving only the final pull tests to be made with the shortened riser. The LT-2076 with the Crane Barge in tow then moved over to the site for installation of Moor #2.

29 Jan.-1230: Installed the first ground leg of Moor #2 including lowering anchor, laying out ground Leg #1, lowering riser, and lowering mooring buoy into the water. Additionally the tricing lines were cut and the two throwoff legs were dropped into the water with crown lines and buoys attached. Considerable difficulty was experienced during the implantment of this leg which

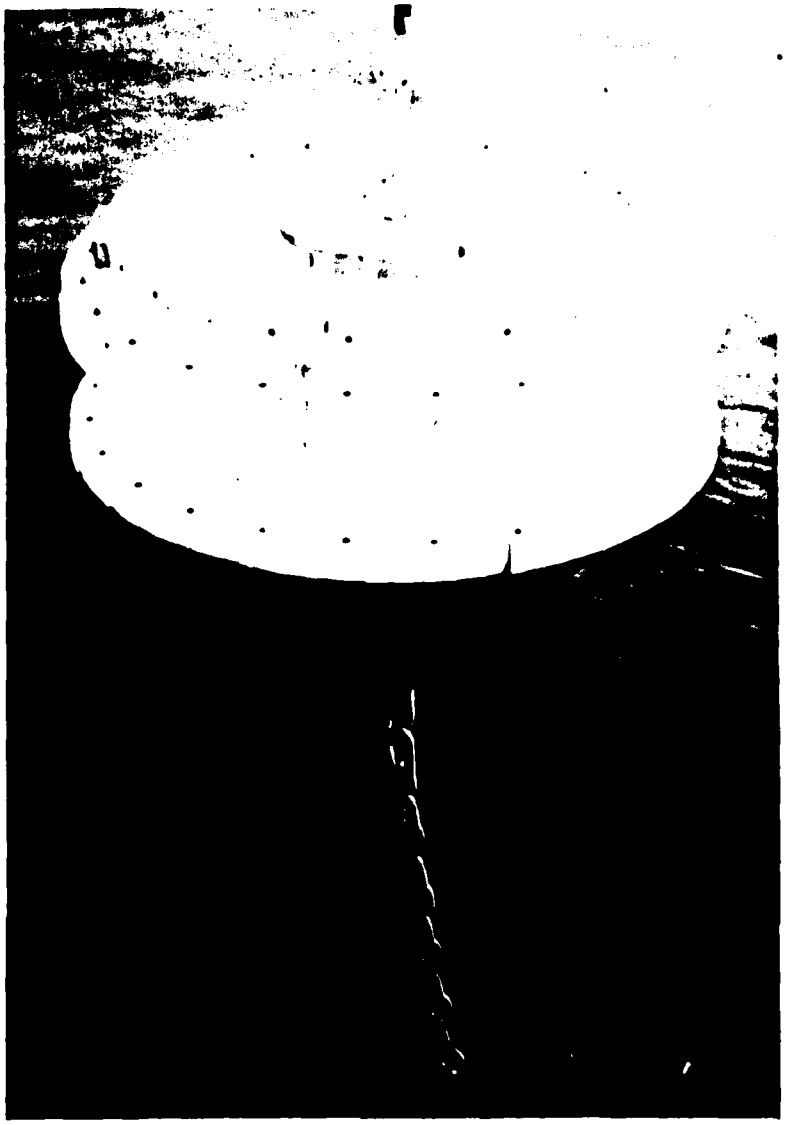


FIGURE A-32: MOORING BUOY #6 LIFTED
PRIOR TO SHORTENING RISER CHAIN

FIGURE A-33: BUOY BACK IN WATER

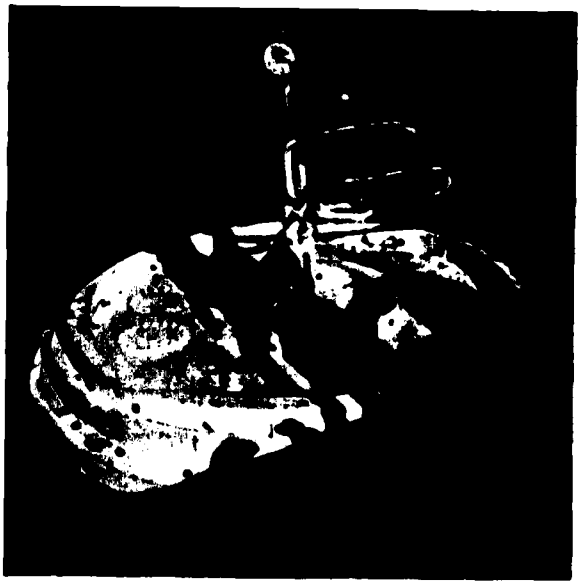


FIGURE A-34: HOIST WITH DYNAMOMETER

required repositioning the marker buoy and involved operational difficulties with the crane. It was not until 1520 that Anchor #1 was on the bottom and it was 1555 before the two throwoff legs had been put overboard.

29 Jan.-1600: The deck of the Crane Barge was rigged for the installation of ground Leg #2 before the BD-6650 returned to the pier at 1635.

30 Jan.-0800: The LT-2076 with the Crane Barge in tow moved back out to the site of Moor #2, Figure A-35. This particular illustration shows the mooring buoy and the center spar buoy marker as well as the crown buoy for Leg #1.

30 Jan.-0816: The crane hook was attached to the buoy for throwoff Leg #2 and the leg was raised level with the Crane Barge deck, Figure A-36, where it was stoppered off and attached to the remaining hardware for ground Leg #2.

30 Jan.-0910: The second ground leg of Moor #2 had been laid similar to that employed in Moor #6. The deck of the Crane Barge was then rigged for laying the third ground leg including tying the crown buoy to the crown line, connecting the crown line to the anchor bridle, reeving the crown line through the snatch block on the crane hook, and readying the anchor for ground Leg #3 for lowering overboard.

30 Jan.-0955: Throwoff Leg #3 was picked up as had been done previously and the end of the chain connected to ground Leg #3.

30 Jan.-1025: After moving west in the direction of the marker buoys for Leg #3 the anchor was lowered. Despite some rigging difficulties ground Leg #3 and the last crown line and buoy were overboard by 1035 and thus all the hardware for Moor #2 was in the water at this point.

30 Jan.-1105: Returned to Mooring Buoy #6, installed the dynamometer, and relifted the mooring buoy with a recorded tension of 27 kips when the buoy was as much as 9 feet out of the water.

30 Jan.-1250: Returned with the two tugs to Moor #2 for the purpose of straightening out the ground legs. Pulled first on ground Leg #1, then on ground Leg #3, and finally on ground Leg #2.

30 Jan.-1510: Hooked up to Mooring Buoy #2 for a pull test prior to shortening the riser. The plot of this test indicated a 65 foot radius watch circle under a 12 kip load.

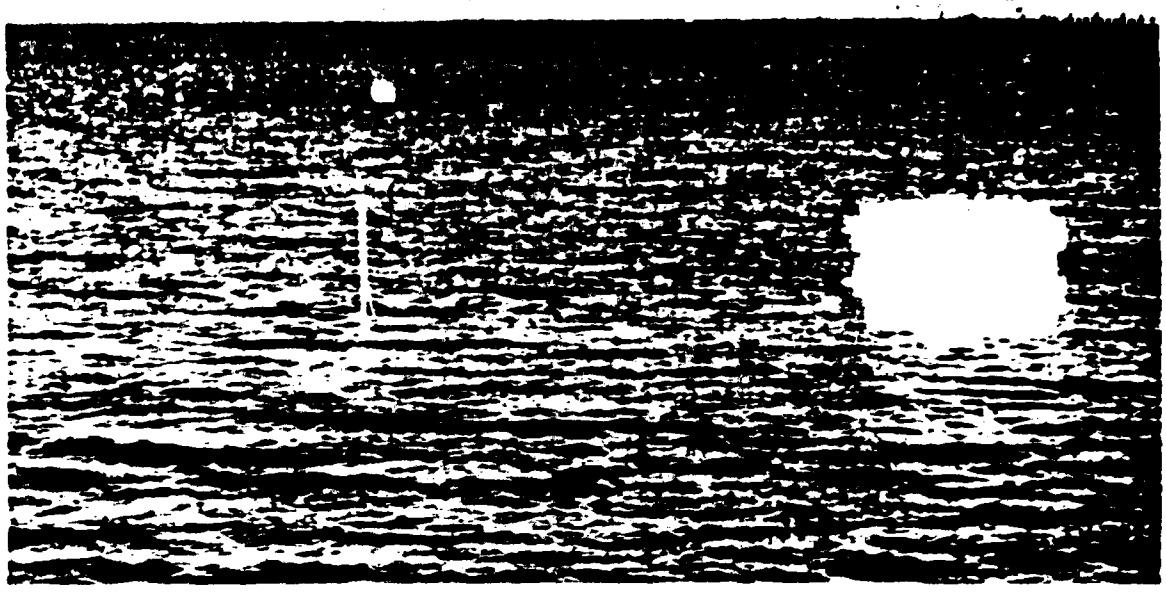


FIGURE A-35: MOORING BUOY, CENTER MARKER BUOY, AND CROWN BUOY FOR LEG #1 OF MOOR #2

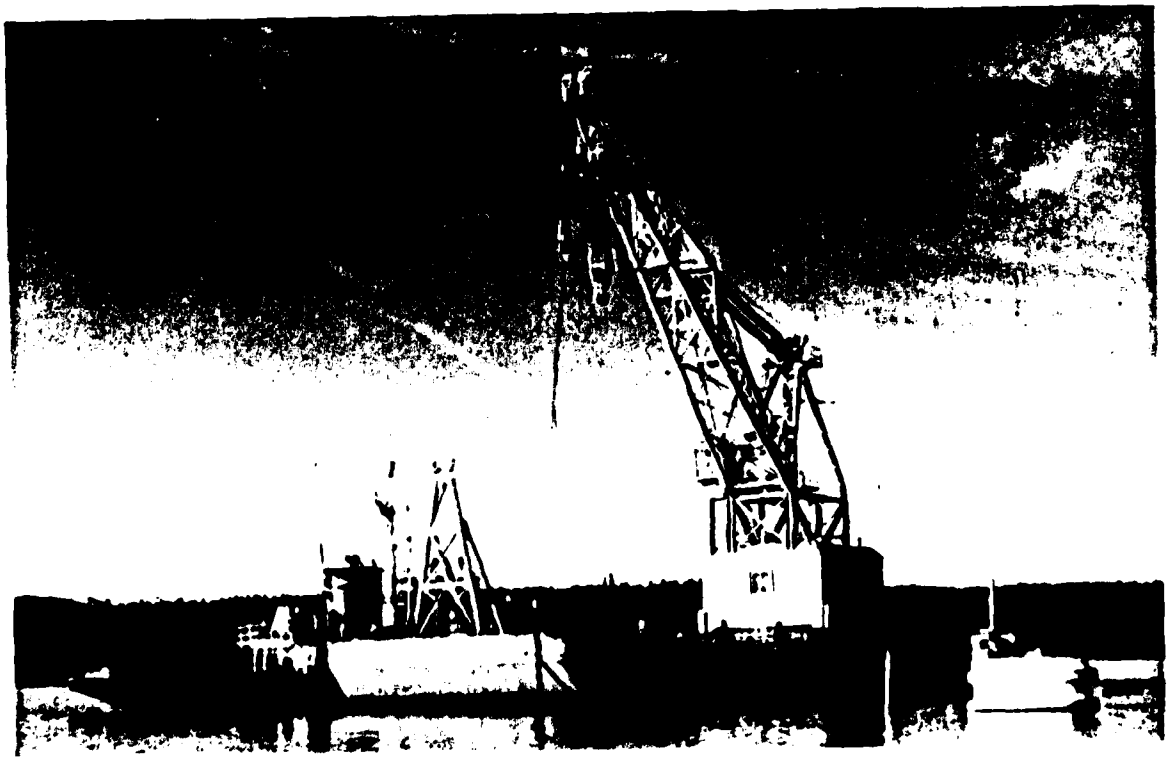


FIGURE A-36: LARGE TUG POSITIONING CRANE BARGE FOR SHORTENING RISER OF MOOR #2

30 Jan.-1625: Marker buoys for Moor #2 were recovered.

30 Jan.-1630: Moved over to Moor #6 to conduct a circular pull test at 7 kips but had difficulty maintaining a circular pull,and partially through the test the Kala Point transponder went dead,so it was decided to terminate for the day and the vessels returned to the pier.

31 Jan.-0905: The ST-2154 went out with the divers to make a visual survey of the installation of Moor #2. It was reported that all three legs looked good but that the anchors appeared to be deeply buried in the bottom.

31 Jan.-0958: The LT-2076 in company with the ST-2154 left the pier to conduct circle pull tests on Moor #6.

31 Jan.-1037: Started the turns on the LT-2076 for a 6 kip pull test and at 1045 there were straight line pull tests conducted with the tug heading 342° True and 163° True. The tug then returned to the pier to bring out the Crane Barge to shorten the riser chain on Moor #2.

31 Jan.-1225: Mooring Buoy #2 was lifted out of the water, 40 feet of excess riser chain removed, and the buoy put back into the water after the chain stopper had been removed.

31 Jan.-1245: A lift test was conducted on Buoy #2 with a dynamometer reading between 30 and 31 kips with the buoy in a position where 9 1/2 riser chain links were out of the water.

31 Jan.-1323: The Crane Barge was towed back over to Moor #6 and that buoy was again raised out of the water in the same position above water as Mooring Buoy #2. This buoy showed a dynamometer reading of 28.5 kips. The vessels then returned to the pier so that the Crane Barge could be rigged for Mooring #1.

1 Feb.-0945: The tugs and the Crane Barge had transited to the site of Mooring Buoy #1 and by 1000 the first ground leg was implanted. The installation procedure followed those described previously with the Crane Barge at the old mooring while the deck was rigged for the second and third ground legs.

1 Feb.-1250: Ground Leg #2 installation was completed.

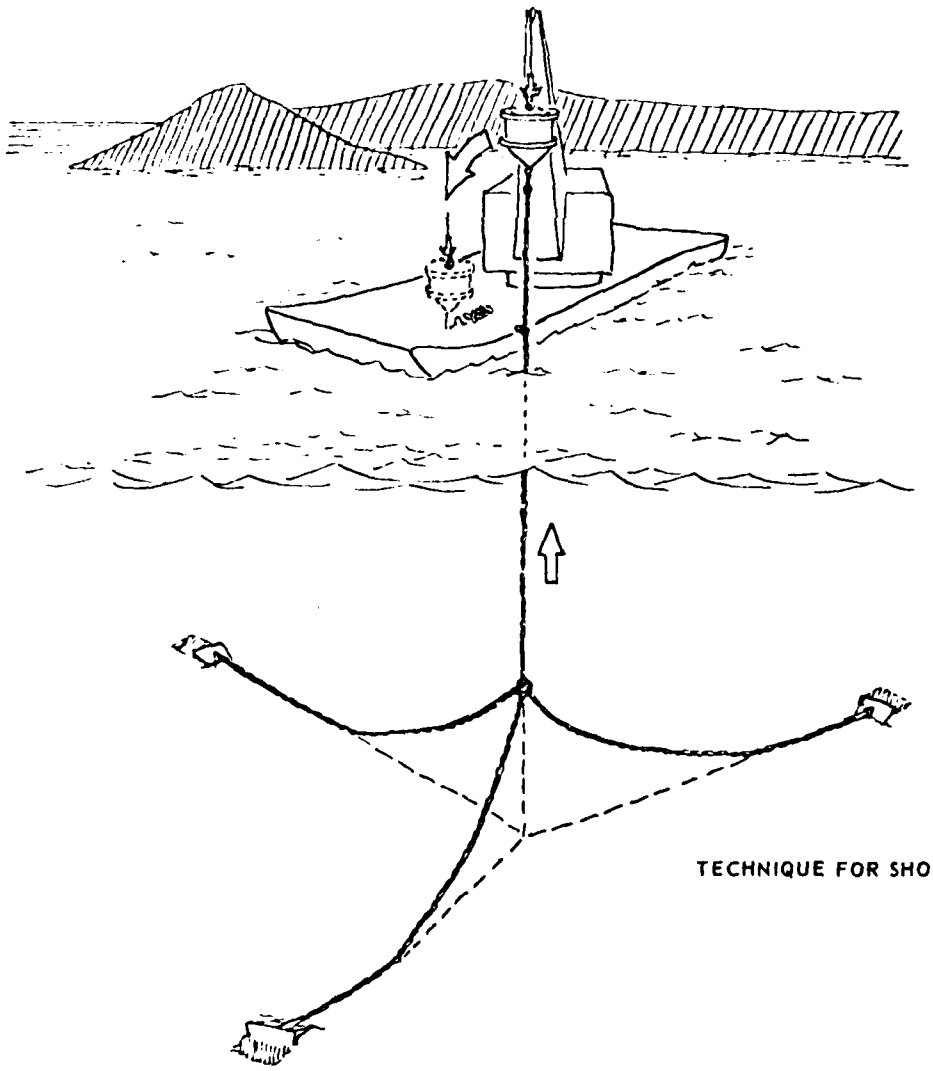
1 Feb.-1530: The installation of ground Leg #3 of Moor #1 was completed and the vessels returned to the pier.

3 Feb.-0745: Prepared to leave the pier to pull on the anchors of Moor #1.

3 Feb.-0920: After a delay awaiting the warming up of the engine on the LT-2076 the tug headed for the crown buoy of Anchor #3 of Moor #1 and this leg was pulled out in the direction of the marker buoys (260° True). Again, as had happened with the previous leg pull outs,there was evidence of breaking of the hook on the bridle supporting the anchor to improve setting.

3 Feb.-1000: Proceeded to the crown buoy for ground Leg #2 and applied a pull to that leg until the mooring buoy movement indicated that the leg was straightened out. Since the mooring buoy was somewhat off position there was no additional pull applied to Leg #1. The tugs then returned to the pier.

3 Feb.-1230: The LT-2076 with the Crane Barge in tow proceeded back out to Moor #1 to shorten the riser chain which followed the same procedures as for the previous two moorings. This procedure is illustrated in Figure A-37.



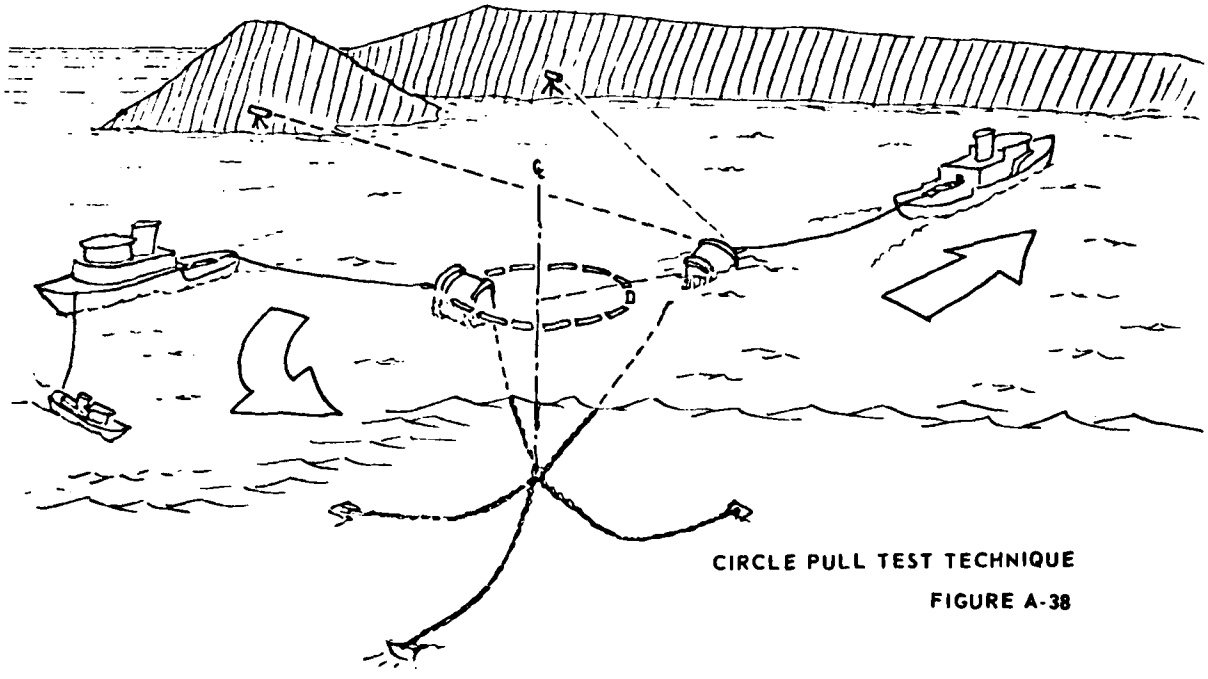
TECHNIQUE FOR SHORTENING RISER

FIGURE A-37

3 Feb.-1300: A lift test was conducted. When the buoy was just out of the water the dynamometer reading was 27.0 kips but, when lifted a few feet above the water the dynamometer reading increased to about 30 kips. After completion of this test the vessels returned to the pier.

3 Feb.-1320: The remainder of the day was spent in conducting pull tests on the three buoys. Figure A-38 illustrates the pull test technique. Figure A-39 illustrates a mooring buoy being pulled and the relative position of the dynamometer. Figure 40 is a closeup photograph of the Dillon dynamometer utilized for these tests. For each buoy a 6 kip circular test was conducted and then a 12 kip straight pull test was run with the pull in varying directions.

3 Feb.-1635: Testing was completed on all three moors at this point. An on-site project review was conducted to evaluate the relevant factors involved in the relocation of the moorings to correct the navigational errors that had resulted in the three moors being roughly 100 ft farther offshore than called for by the initial design. The tests demonstrated that the moorings were satisfactorily implanted and the stipulated watch circle diameters had been met with the designed horizontal load applied to the buoys. Furthermore, the minimum separation requirements had been met and there was adequate room to install the remaining three buoys of the overall system. As a result of this review a decision was made that there was no logical rationale that called for the relocation of the moorings. The tugs were therefore ordered to pick up the three sets of crown buoys thus completing the construction effort.



CIRCLE PULL TEST TECHNIQUE

FIGURE A-38

FIGURE A-39: PULL TEST ON MOORING

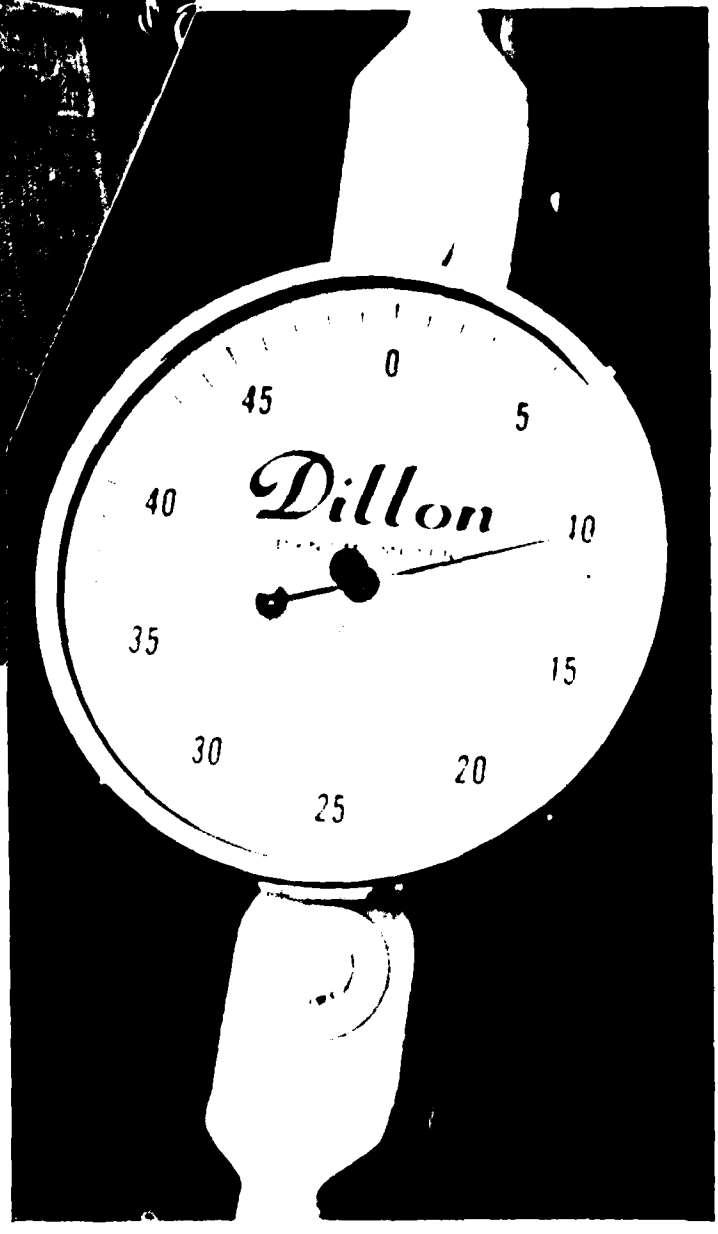


FIGURE A-40: DYNAMOMETER FOR PULL TEST

3 Feb.-1815: All vessels had returned to the pier and the Indian Island Mooring Installation was completed. All gear was loaded from the Crane Barge to the CEL truck and to other rental cars for return that night to Port Townsend.

4 Feb.-0840: The CEL truck departed to return equipment to CEL and to PWC. FPO-1 made a final check on the Kala Point site navigation markers and then a final visit to Indian Island to inspect conditions and to return transits to the ROICC. The WSMC vessels and all other personnel then departed for return to their respective stations.

APPENDIX B

KALA POINT TRANSPONDER
SITE DISCREPANCY ANALYSIS

FPO-1P (PDC):cgw
8 March 1979

MEMORANDUM

From: Thomas J. O'Boyle
To: Indian Island Mooring Project File

Subj: Mini-Ranger Transponder Site Discrepancy, Kala Point

Ref: (a) FONECON btwn Mr. T. O'Boyle (CHESNAVFACENGCOM) and Mr. W. Baxter (Army Corps of Engineers, Seattle, WA) of 19 SEPT 1978
(b) FONECON btwn Mr. T. O'Boyle (CHESNAVFACENGCOM) and Ms. A. MacLean (NOAA, Seattle, WA) of 2 FEB 1979
(c) FONECON btwn Mr. T. O'Boyle (CHESNAVFACENGCOM) and Mr. A. Winther (Army Corps of Engineers, Seattle, WA) of 12 FEB 1979
(d) CHESNAVFACENGCOM ltr of 28 FEB 1979

Encl: (1) Calculations
(2) Information on KUHN
(3) Survey of Kala Point

1. On 19 September 1978 the 13th Coast Guard District in Seattle, Washington was contacted and requested to provide the coordinates for the light on Kala Point. They responded with the latitude and longitude taken from a chart. The need for the exact location was explained, and the Coast Guard suggested to contact the Army Corps of Engineers in Seattle, WA at (206) 764-3495. The Army Corps was called that same day, reference (a), and informed of our needs. Mr Warren Baxter of the Permit Section explained he was not the correct man to talk to; however, he was able to have the information relayed by telephone. The coordinates were thought to be for the light on Kala Point, but on 15 November 1978, during the site survey, no evidence of a survey mark could be found on the light while trying to install the Mini-Ranger transponder. However, there was a monument on top of a sand dune approximately 30 meters to the West. This was assumed to be the point.

2. This same point was again used during the installation starting 27 January 1979. Signals from Kala Point were received over the entire installation area. However, because the old pier was situated between the installation area and the Indian Island transponder location (Crane Point), the crane barge blocked this signal at times. Loss of signal from one transponder rendered the Mini-Ranger inoperative and made the installation of the marker buoys for Mooring 1 impossible. On 31 January 1979, it was decided to set up a transit, together with the Mini-Ranger console on Walan Point. The coordinates for this point were identified in NAVFAC Drawing Number 6, 045, 831. To set the marker buoys, a transponder was placed in a small boat and, with a backsight on Kala Point, the azimuth and range to each buoy was obtained. The angle and range to each buoy was calculated along with the internal angles of the triangle formed by Kala-Walan-Crane.

FPO-1P (PDC):cpw
5 March 1979

Subj: Mini-Ranger Transponder Site Discrepancy, Kala Point

The difference between the calculated angles and the measured angles of this triangle moved the location of Kala approximately 158 feet West. (Enclosure (1)). Angles to the three installed mooring buoys' were also taken from Kala and Walan Points. When these vectors were plotted over the range-range locations the points did not match. This discrepancy and the difference between the calculated and measured internal angles of the triangle formed by Kala-Walan-Crane, raised a question about the coordinates for the monument found on Kala Point.

3. On Friday morning, 2 February 1979, an effort was made to locate a second source for the coordinates of Kala Point. A local Port Townsend surveying company, Peninsula Surveying, was called, and asked, if they had any record of these coordinates. They did not, but suggested to call NOAA in Seattle, WA at (206) 442-7657. They reasoned that NOAA took over the Coast and Geodetic Survey duties and should have all the old records. Ms. Annie MacLean of the Office of Technical Assistance said, there are several monuments at Kala Point (reference b). The original was called KUHN and was established in 1920 at E 1, 527, 368.16 and N 391, 829.07. Another point called KUHN-2 was established in 1941 at E 1, 527, 417.25 and N 391, 865.24. This new point has two reference marks, RM-1 and RM-2. Both reference marks have a bronze disk set in a 5-inch circular concrete monument. RM-1 is located 20.967 meters at an angle of 201° 32' 03" true and RM-2 is 23.702 meters at an angle of 265° 05' 04" true from KUHN-2. The bronze disk is labeled KUHN-2 1941, No.1 and KUHN-2 1941,No.2 respectively. Having this information, Kala Point was revisited on the afternoon of 2 February 1979, to identify the monument on which the transponder was secured. While at Kala Point another Monument was found; this one is a 4-inch square concrete monument with a brass screw in the center and a square galvanized bolt in the NE corner. The letters U.S.E.D. are written on the south edge. That same afternoon, NOAA was given this description and they reported the original KUHN had been found. (Enclosure (2)). The other monument, to which the transponder was secured, labeled KUHN No.1 USE on the brass disk, must be a reference mark for KUHN for which NOAA had no record or description.

4. Because of the small relative distances involved in proof loading, transits were used to determine the final location of the installed moorings. The transits were set up on the Walan and Cliff Monuments identified in NAVFAC Drawing No.6, 045, 831. These two points and KUHN were used to survey in the reference mark for KUHN and the light on Kala Point. (Enclosure (3)).

5. To confirm the coordinates orginally received from the Army Corp of Engineers, reference (a), the Seattle, WA office was again called on 7 February 1979. Mr. Baxter said that Mr. Arlie Winther would check with his source in the surveying section, where he got the original information. On 12 February 1979, Mr. Winther said the coordinates were for the Kala Point lighthouse and these coordinates are E 1, 527, 484.39 and N 391, 817.13.

FPO-1P (PDC):cgw
5 March 1979

Subj: Mini-Ranger Transponder Site Discrepancy, Kala Point

After comparing these new coordinates with those received on 19 September 1978, a difference of 100 feet between the two East coordinates was revealed. The new coordinate moves the point 100 feet inshore on Kala Point.

6. The coordinates received in reference (a) define a point on the water's edge approximately 216.5 feet from KUHN. The 100 difference in the East coordinates, appeared to move the point to the vicinity of the Kala Point light. However, the point is located 43.28 feet South and 2.61 feet East of the light, (Enclosure (1)). There is nothing visible at this location that would indicate the spot had been surveyed. The coordinates of the reference mark for KUHN were calculated to be E 1, 527 416.13 and N 391, 865.66, (Enclosure (1)). Using these coordinates the range-range data taken during the installation could be replotted.

7. To avoid this type of discrepancy in the future it is recommended to contact NOAA's National Geodetic Survey Office in Rockville, MD, at (301) 443-8631. Information on the description/location of triangulation stations, like KUHN on Kala Point, Washington, can be obtained from that office.

Thomas J. O'Boyle

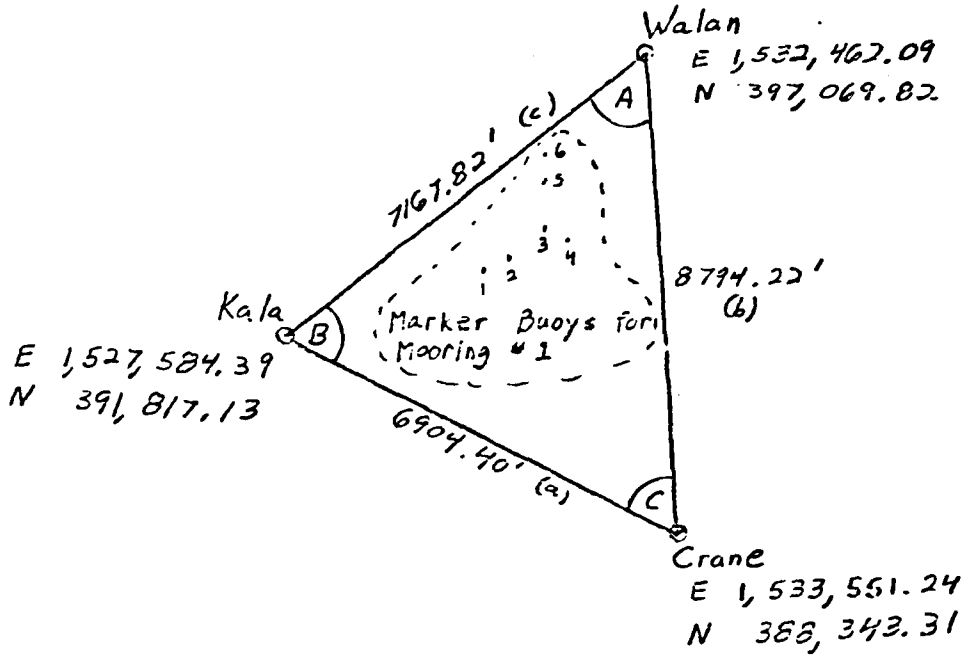
THOMAS J. O'BOYLE

Copy to:
FPO-1C
FPO-1C6
FPO-1P(PDC)
Daily

CALCULATIONS

1. Calculate internal angles of triangle Kala-Walan-Crane.

a) Distance $= \sqrt{(E-E)^2 + (N-N)^2}$



b) Law of Cosines

$$c^2 = a^2 + b^2 - 2ab \cos C$$

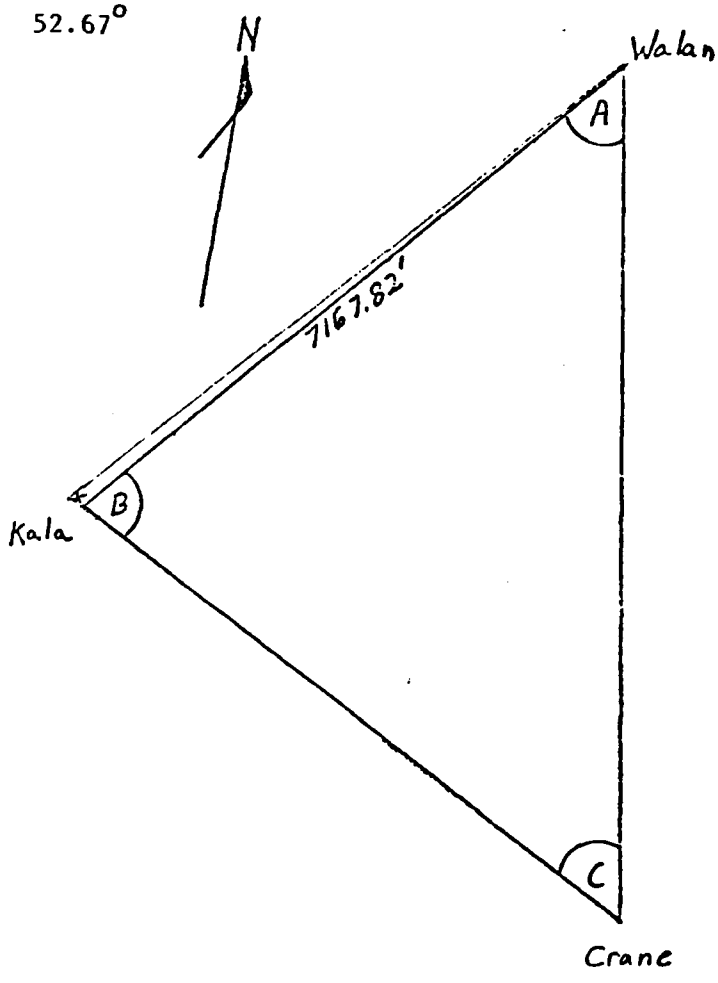
$\angle A = 49°59'29''$
$\angle B = 77°20'13''$
$\angle C = 52°40'18''$

Buoy	Angle	Range (M)
1	13°16'50"	986.22
2	14°16'23"	963.26
3	25°08'49"	807.93
4	33°25'29"	868.10
5	22°10'51"	584.59
6	21°35'28"	554.84

Enclosure (1)

2. Difference between Calculated and Measured Angles of Triangle Kala-Walan-Crane.

ANGLE	CALCULATED	MEASURED	DIFFERENCE
A	49.99^{o}	51.23^{o}	1.24^{o}
B	77.34^{o}	75.77^{o}	1.57^{o}
C	52.67^{o}		



3. Find distance between the two points at Kala using Law of Sines

$$\frac{a}{\text{Sin}A} = \frac{b}{\text{Sin}B} = \frac{c}{\text{Sin}C}$$

$$\frac{7167.82}{\text{Sin } 75.77} \cong \frac{X}{\text{Sin } 1.24^{o}}$$

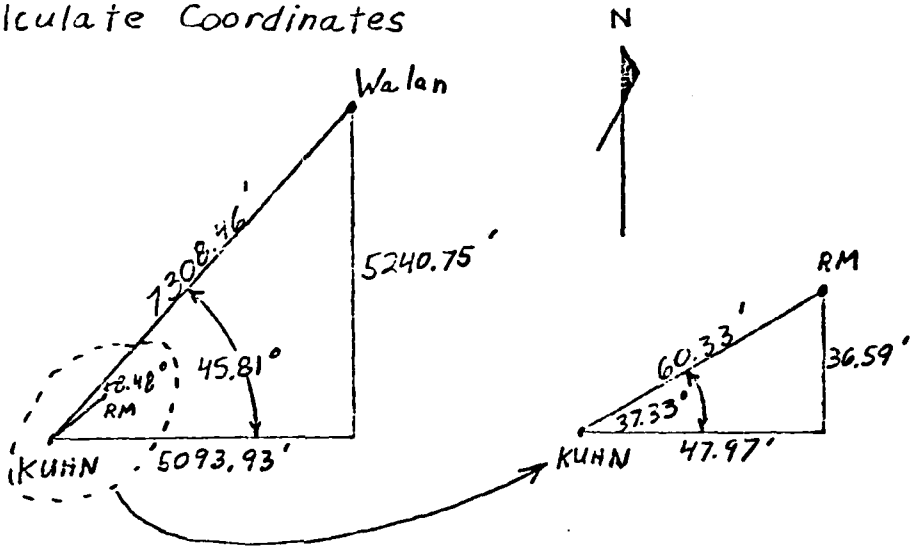
$X \cong 158$ feet (WEST)

Enclosure (1)

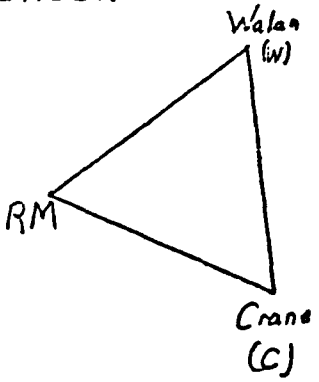
4. Coordinates of the Reference Mark for KUHN.

Using the coordinates for KUHN together with the angle and distance to the reference mark, the coordinates for this reference mark were calculated to be, E 1, 527, 416.13 and N 391, 865.66. These coordinates were checked by comparing the calculated internal angles of the triangle Walan-Crane-Reference Mark to those measured.

a) Calculate Coordinates



b) Check



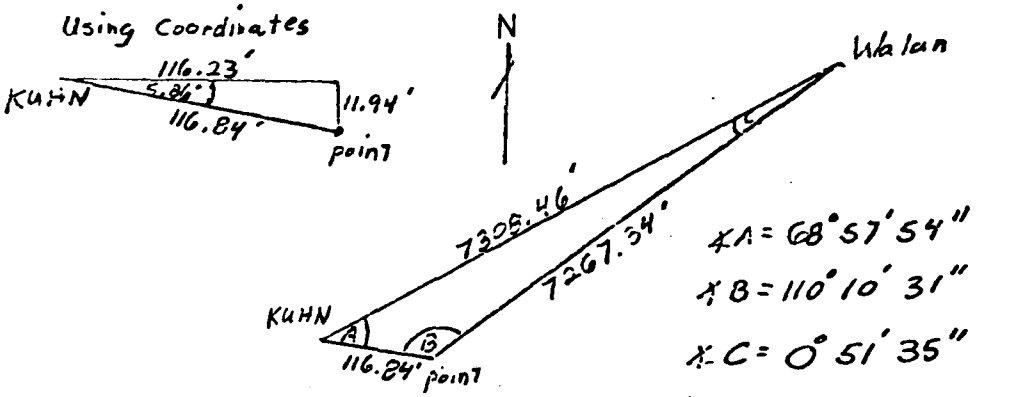
Angle	Calculated	Measured
W-RM-C	75°41'	75°46'
RM-W-C	51°12'	51°14'

Enclosure (1)

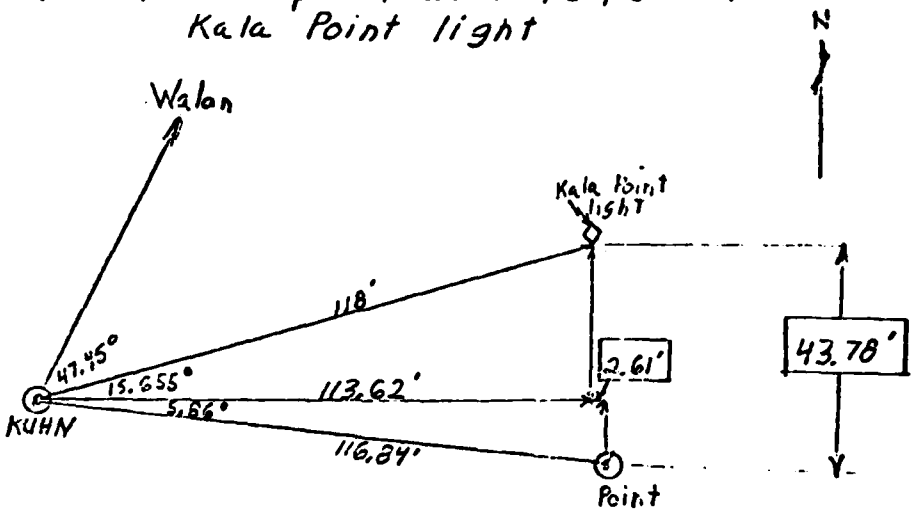
5. Locate the Army Corps Point.

The angle and distance from KUHN to the new Army Corps coordinates were calculated. This put the point 116.23 feet East and 11.94 feet South of KUHN at an angle of 68° 57' 54". Which means this point is 43.78 feet South and 2.61 feet East of the Kala Point Light.

a) Distance from KUHN to Army Corps Coordinates



b) Location of point with respect to Kala Point light



Enclosure (1)

INFORMATION ON KUHN

The information for KUHN USE came from the following sources:

GEOGRAPHIC POSITION

Geographic Positions of triangulation stations in Washington State, Vol. 1, page 1504.

PLAIN COORDINATES

Plain Coordinates North Zone Washington State coordinate Systems, page 309.

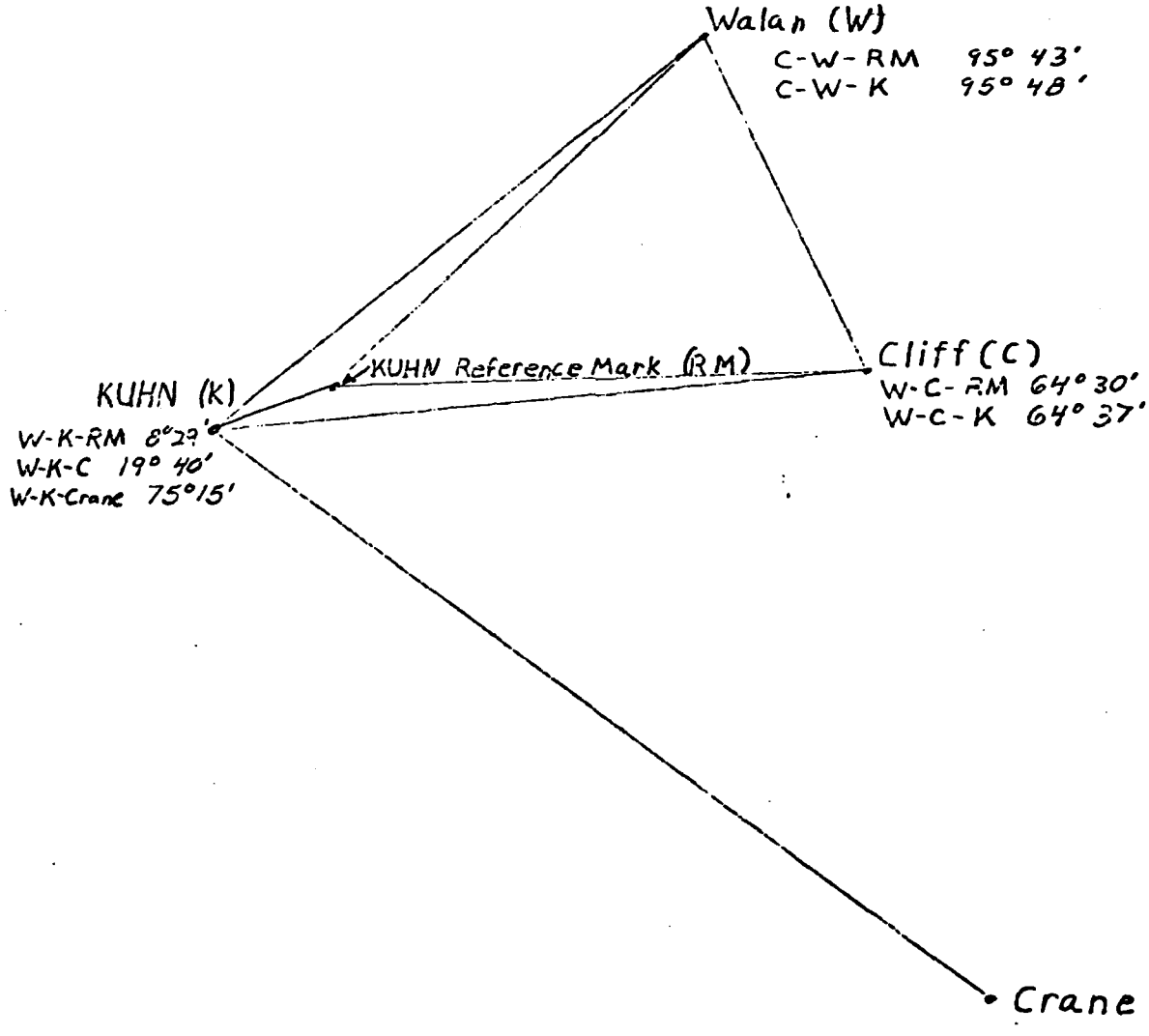
WHERE TO FIND

Description Book No. 440, pages 5, 9, 10 and 31.

Enclosure (2)

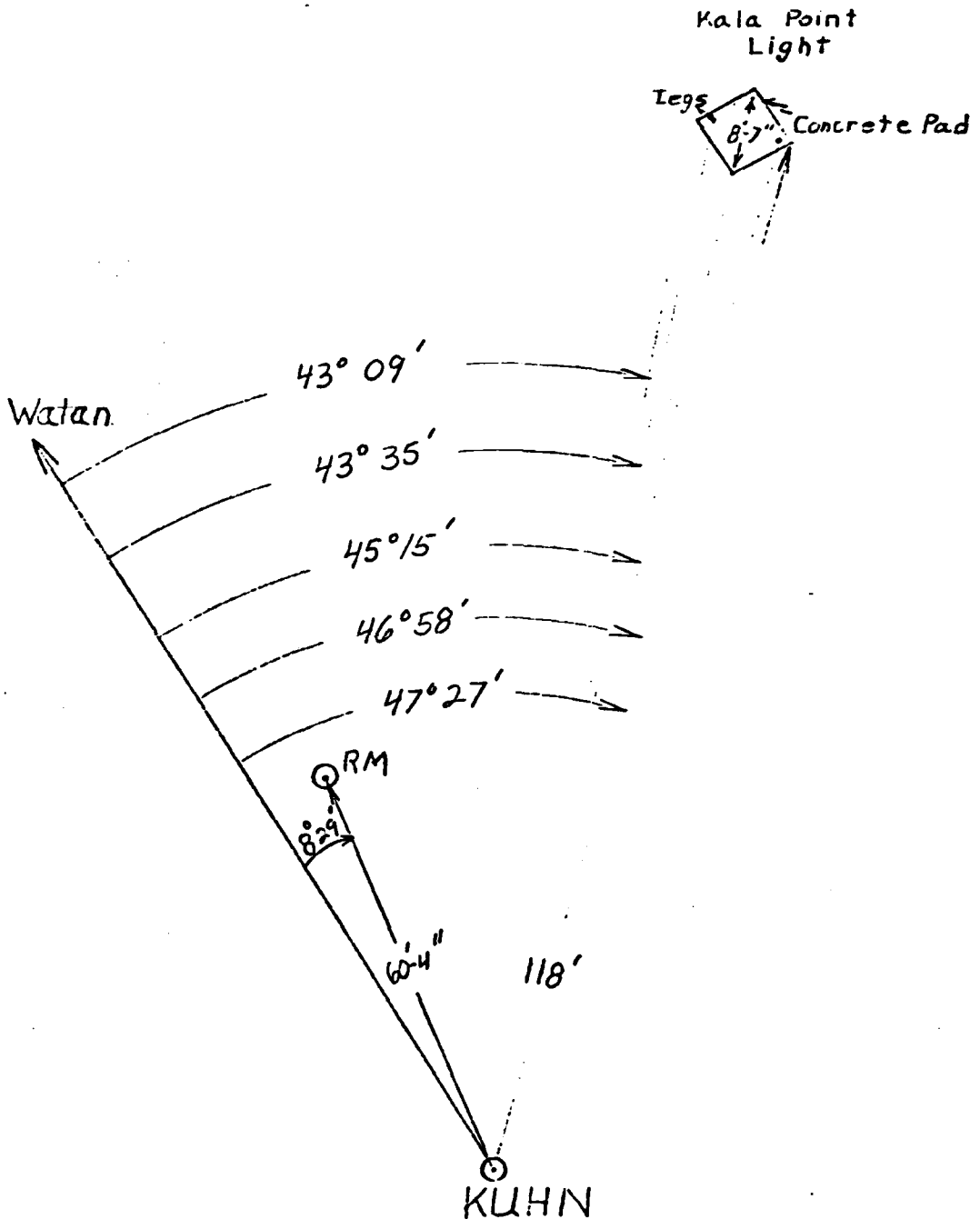
SURVEY OF KALA POINT

Using two surveyed points identified in NAVFAC Drawing Number 6,045,831, Walan and Cliff, on Indian Island for transit sites, the locations of all the moorings were obtained. Using these same two points and KUHN, the reference mark for KUHN and the light on Kala Point were surveyed in before departing the area.



Enclosure (3)

SURVEY OF KALA POINT



Enclosure (3)

APPENDIX C

PRELIMINARY REPORT OF INDIAN ISLAND MOORING INSTALLATION

DEPARTMENT OF THE NAVY
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
BUILDING 57, WASHINGTON NAVY YARD
WASHINGTON, D.C. 20374

IN REPLY REFER TO:
FPO-1C6:db
11000

28 FEB 1979

From: Commanding Officer, Chesapeake Division, Naval Facilities Engineering Command
To: Officer in Charge of Construction, Naval Facilities Engineering Command, TRIDENT

Subj: Indian Island Moorings

Ref: (a) CHESNAVFACENGCOM ltr of 18 January 1979
(b) NUWES ltr of 16 January 1979
(c) Phone Conversation btwn Mr. A. Kurtz (CHESNAVFACENGCOM) and Mr. R. Hess (NUWES), 2 February 1979

Encl: (1) Coordinates for Fleet Moorings Number 1, 2, and 6-Table
(2) Site Plan - Fleet Moorings, Indian Island Annex

1. Installation of Fleet Moorings Number 1, 2, and 6 for the Indian Island Annex occurred during the period 22 January to 3 February per the construction schedule provided by enclosure (1) of reference (a). Each mooring was proof tested to the design load of 12 kips and determined to meet the minimum separation distances specified by reference (b). However, a discrepancy in control point location resulted in a general displacement of the moorings approximately 100 feet southwest of the desired locations. Enclosure (1) presents a comparison of the design and as-built locations of these moorings.

2. Positioning of the moorings during installation was controlled by a Motorola Mini-Ranger System which provided range-range readings from two control points established at Crane Point and Kala Point. Because of the small relative distances involved in proof loading transits were used to determine the final location of the installed moorings. Two new control points providing a view of the construction area were established on Indian Island using survey control points identified in NAVFAC Drawing Number 6, 045, 831. Transit fixes of the moorings placed them to the southwest of the desired locations. The cause for this discrepancy was later determined to be an error in the coordinates locating the control point at Kala Point.

FPO-1C6:db
11000
20 FEB 1979

Subj: Indian Island Moorings

3. The watch circle of each mooring obtained under full design load is provided in enclosure (2). Moorings Number 2 and 6 performed well within the design predictions. The oblong watch circle obtained for Mooring Number 1 indicates the southeast anchor leg may not have obtained the desired catenary and thus allows a greater displacement along its line of action. However, an on-site review of the as-builts revealed all three moorings maintained the required separation distances and the additional two days estimated to reconstruct Mooring Number 1 was not warranted.

4. By reference (c), CHESDIV was requested to recover an old mooring in the area as part of the construction operations. This mooring was recovered on 2 February 1979, and placed on one of the YC barge previously used to store components for the new moorings. This recovery was accomplished in the existing construction schedule. Per reference (c), separate funds will be provided by NUWES, Keyport to cover the cost of this recovery.

5. As-built drawings are now in preparation and will be forwarded with a completion report for your review and retention.

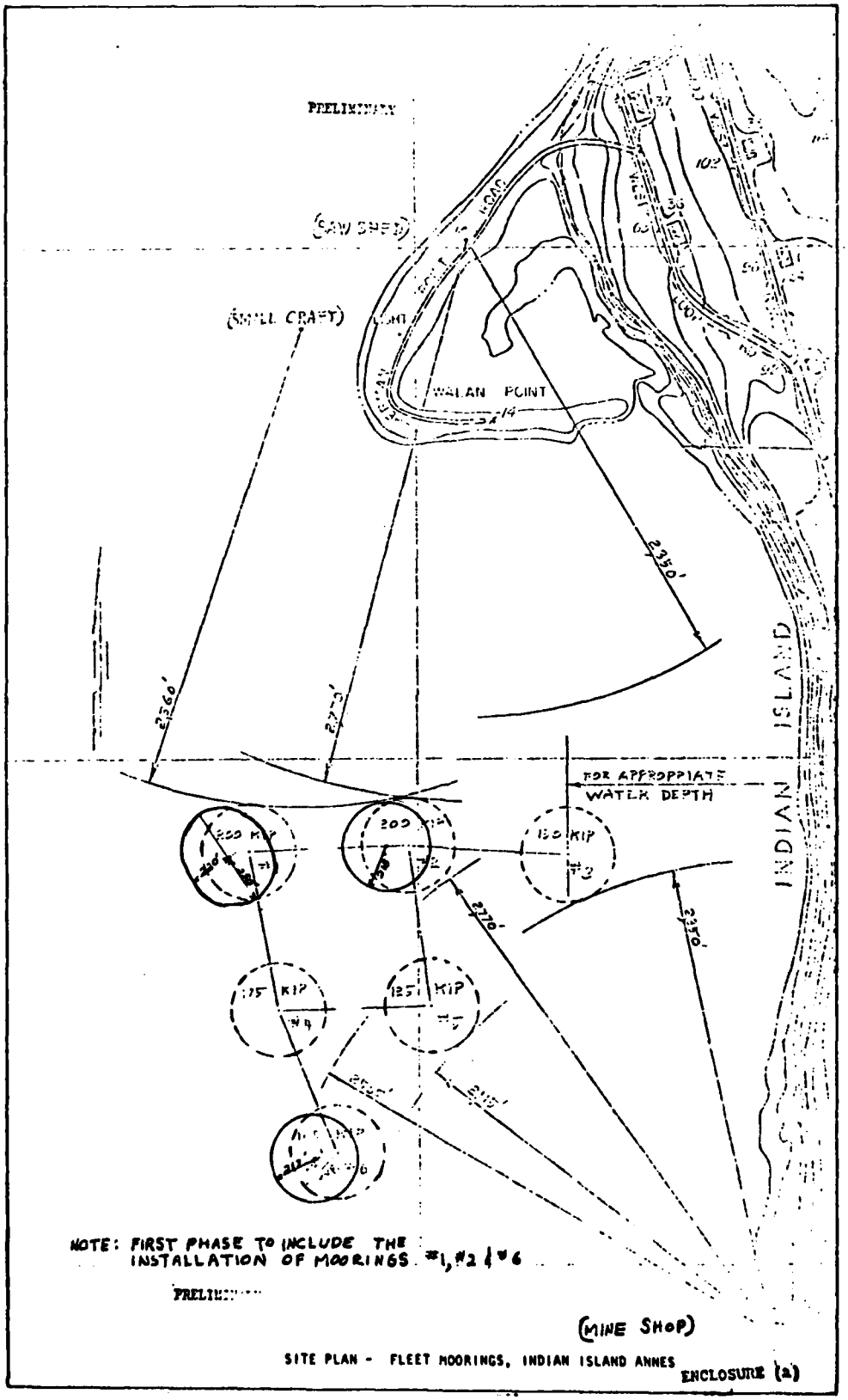
J. A. STAMM
By direction

COORDINATES FOR FLEET MOORINGS

NUMBER 1, 2, AND 6

MOORING #	DESIGN	AS-BUILT	DIFFERENCE OF AS-BUILT FROM DESIGN
1	N 394,545 E 1,531,655	N 394,519 E 1,531,558	S 26 ft W 97 ft
2	N 394,570 E 1,532,455	N 394,572 E 1,532,350	N 2 ft W 105 ft
6	N 393,052 E 1,532,088	N 393,026 E 1,531,963	S 26 ft W 125 ft

Enclosure (1)



SITE PLAN - FLEET MOORINGS, INDIAN ISLAND ANNES

ENCLOSURE (2)

APPENDIX D

PERSONNEL OF VARIOUS ORGANIZATIONS PARTICIPATING IN THE INDIAN ISLAND MOORING PROJECT

FPO-1

A. J. Kurtz - Project Manager

S. Ling - Design Manager

T. J. O'Boyle - Design Engineer/Navigator

L. Mendlow - Assistant Navigator

WSMC

CW4 R. Bishop - Watercraft Maintenance Center

CW4 Frederick E. Clifton - Tug Master

John A. Hazel - Chief Engineer

Donald A. Woodard - Senior Seaman

Robert J. Langren - Senior Seaman

Douglas G. Miller - Chief Engineer

Joseph H. Harrison - Engine Man

George J. Hagedorn - Senior Engine Man

James M. Sauget - Engine Man

Rodney A. Swaleson - Engine Man

Osgar D. Jones - Engine Man

Charles K. Davis - Crane Operator

James E. Pedersen - Senior Engine Man

Earling B. Hansen - Engine Man

Craig G. Roen - Engine Man

Tony D. Petty - Seaman

Gerald Peterson - Seaman

PWC, San Diego

D. Jockell - Fleet Mooring Rigging Foreman

B. Odell - Rigger

T. Collis - Rigger

CEL

Lt. W. F. Walker - Diving Officer

BUCS D. Thompson

OICC TRIDENT

CDR J. Stark

D. Clinkenbeard

ROICC Indian Island

LCDR T. Gunn

NUWES Keyport

LCDR D. Looff - Industrial Support Group

R. Hess - Industrial Support Group

Lt. G. Schlomer - Diving Officer